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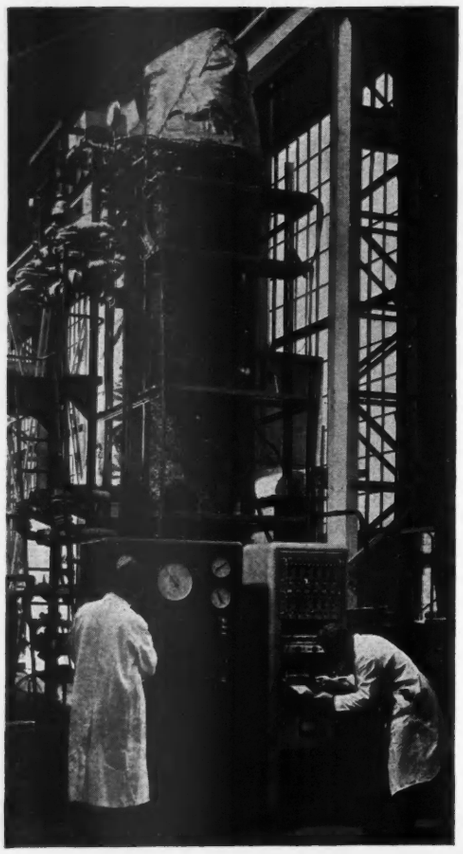

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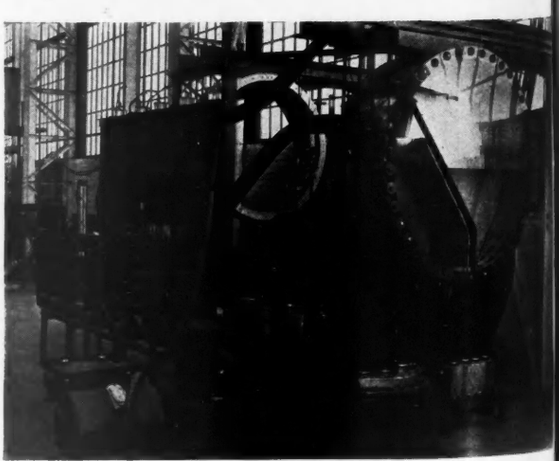

TOP: *Testing Flow Stability. This apparatus is used to simulate flow conditions in assisted circulation and 'once-through' boiler circuits to provide design information.* CENTRE: *Heat transfer and flow loss testing of tube nests.* RIGHT: *Full size section of boiler drum in which tests are carried out to investigate the effectiveness of steam separation, using water and air simulation of flow conditions*

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Welding sections of a cast steel tube pile for the cooling water intake structure at the Dungeness nuclear power station. (*Nurnberg photograph for* ENGINEERING)

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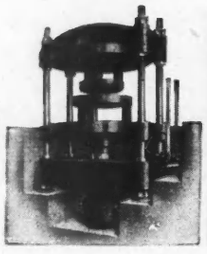

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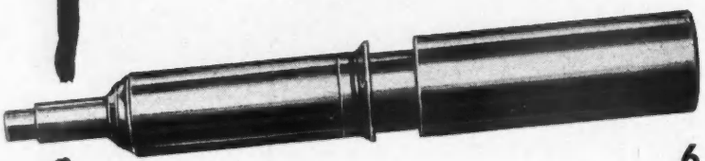

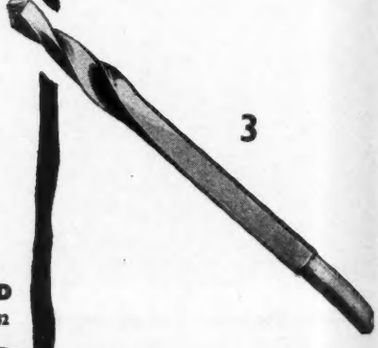

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ENGINEERING Impact

of Consulting Engineers' Tender Spot

BY opening the Mangla dam tenders in public last week the consulting engineers were mindful of their profession's current interest in publicity—publicity which the consultants need if they are going to stay in international business, looking after major schemes overseas.

Last Wednesday's occasion was the first time that tenders of any magnitude have been opened in public in Britain, though it is a common enough practice in the United States. To Binnie, Deacon and Gourley, the consulting engineers, must go the credit for the innovation. They got a poor showing in the national Press, as compared to the mentions that the contractors who bid received.

The contract is a big one. The three lowest bids—there were four altogether—averaged £132 million. The Mangla Dam will be a principal part of the Indus Basin development, a 10,000 ft long earth dam across the Jhelum River, and, not surprisingly, the opening of the tenders attracted a lot of attention. At Caxton Hall, London, as many would-be watchers were crammed in the passage outside the door as got inside the room. Representatives of the contractors had come from North America, from the Continent and from the Indian sub-continent to join their colleagues from the British firms who were represented in three of the consortia who tendered. The prices submitted by all four groups were chalked up on a blackboard as each packet of documents was opened; and those who were in a sweepstake on the result considered their chances as each figure went up.

In the event the lowest bid came from an all-American group—Guy F. Atkinson—but the final choice of contractor will take into account limiting and escape clauses. The decision is expected in January.

Research Rewards in Cash

THE pattern of Britain's industrial development in recent years has shown a marked increase in the production of technical goods. This point was stressed by Sir Harry Melville, Secretary of the Department of Scientific and Industrial Research, when giving a talk to the Manchester Statistical Society. Under the title: "DSIR—Does It Pay Off?" Sir Harry's talk revealed some interesting facts about the Government's role in industrial research.

Work in the research associations, which are financed jointly by industry and the Government, has expanded by 50 per cent since 1959. The total income of the 52 research associations is £8 million, of which 25 per cent is provided by the DSIR. The Department's own research stations, of which there are now fifteen, have an income of just over £7½ million. This makes the current research expenditure of the DSIR almost £10 million per annum.

Does it pay off? That was the question posed by Sir Harry in his talk, in which he used both qualitative and quantitative arguments to show that it does. The quantitative argument was almost unique in this context, since it has always been considered practically impossible to assess the dividends of research in terms of cash. The example was based on a study of the Forest Products Research Laboratory, which was chosen because it serves a fairly self-contained industry, and because, at the time, there was virtually only one centre of research.

"It was found that while the labour force of the timber using industries between 1949 and 1953 had remained nearly constant, the total net output of the saw-milling, joinery and furniture industries, taken together and revalued at 1949 prices, was £35 million higher in 1953 than it was in 1949. Even after servicing the new capital investment at a notional rate of 10 per cent, there still remained over £30 million to be attributed to the originators of new technology."

Sir Harry went on to say: "Enterprise and the general advance in mechanization would undoubtedly have achieved increases in productivity even without the specialized work of the Forest Products Research Laboratory. But even if the latter could claim only a quarter of the additional income, £7½ million at 1949 prices, the value of its work was still over sixty times its current cost."

Liaison Between Productivity and Waste

PRODUCTION of saleable articles and generation of waste will always co-exist in industry. It is from recognition of this fact that there has emerged the now growing strength of the National Industrial Salvage and Recovery Council, whose aims are to stimulate the maximum recovery and economical use of redundant or waste materials and by-products.

At a luncheon on 9 November at the time of the annual conference of the NISRC, Mr. Geoffrey Parker, undersecretary to the Board of Trade, and Sir Charles Norris, director of the British Productivity Council, both welcomed closer liaison between the two councils, the one for stimulation of production and the other for the stimulation of the sound use of waste.

The words of Mr. Geoffrey Parker in this respect need little comment. "To the extent that industry is successful in increasing its productivity, salvage problems may become less acute. Similarly, good store-keeping and plant maintenance can prevent the build up of superfluous and out-dated stock. I am sure that you gentlemen will be the last people in the world to regret any healthy development on these lines which may, in certain directions, reduce the need for your services.

"If I may say so, your activities are a welcome contrast to the many pressures these days for a 'throw it away and buy a new one' society. Some of you may remember a recent book by an American—Vance Packard—called *The Waste Makers*. This book castigates modern society as being based on ostentatious consumption and planned obsolescence. Mr. Packard quotes Dorothy L. Sayers as saying 'a society in which consumption has to be artificially stimulated in order to keep production going is a society founded on trash and waste'. This may be a rather unfashionable point of view these days, but perhaps we could all agree that a society which takes some trouble to reduce waste and find good uses for 'trash' can claim some redeeming features."

Lapped Surfaces at Reduced Costs

NEW large lapping machines for producing plane surfaces are likely to have far-reaching effects.

The production of flat surfaces with a very high surface finish, with or without flatness of an optical degree, has been very costly in the past. The introduction of large lapping machines, which are now available with lapping plates up to 7 ft in diameter, enables larger surfaces or alternatively a large number of smaller parts to be lapped at one time, to limits of extreme accuracy. This latter feature means that the cost of lapping components of small area may now be measured literally in a few pence. Machines with lapping plates of up to 26 ft in diameter are contemplated.

In some industries the production of surfaces which are optically or near-optically flat is essential, but there are many other industries where it is highly desirable. Machine lapping is particularly applicable where one lapped surface is required, or where numerous surfaces are involved which do not have to be held within exceedingly close limits relative to each other. Machine lapping may well become the first process on a workpiece, instead of the last, for it can provide a reference plane for subsequent setting out.

A feature of plate lapping machines is that the attention required is almost limited to lifting the work and on off the machine, as clamping is eliminated.

This method of machining is currently arousing much interest and its extension is being facilitated by the larger machines now coming into production (see New Plant and Equipment p. 680, this issue).

Continued Growth of the Profession

WHEN the integration of the engineering profession is discussed, what is meant by the "engineering profession?" In Britain this question has been asked but never answered with authority or in generally accepted terms.

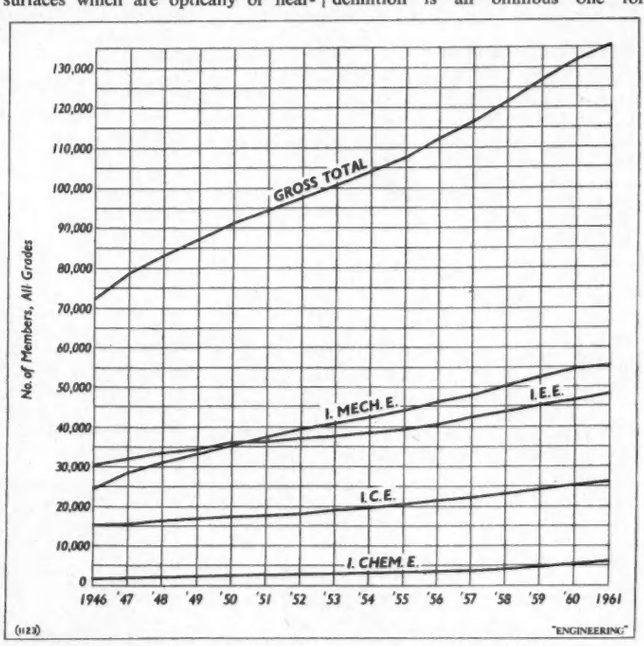
At one time it was customary to give pride of place to members of the three major or primary bodies—the Institutions of Civil, Mechanical, and Electrical Engineers. Then a strong case was made on behalf of the Institution of Chemical Engineers—the "fourth primary technology," to use Sir Harold Hartley's telling phrase.

An important consequence was that the Engineers' Guild decided that membership of one of these four would be the basic requirement for membership of the Guild.

A much wider definition of the profession is used by the Government's Committee on Scientific Manpower. It includes university graduates, holders of the Diploma in Technology, associates of certain educational institutions, and graduate and corporate members of sixteen professional institutions. The definition is an omnibus one for "qualified scientists and engineers," and two of the institutions are for scientists. But this still leaves fourteen institutions of engineers (and metallurgists).

If we take the narrow definition of the profession (the four primary institutions) and include all grades of membership, the graph shows that the number of professional engineers has almost doubled since 1946. (An allowance should be made for those engineers who are members of more than one institution.

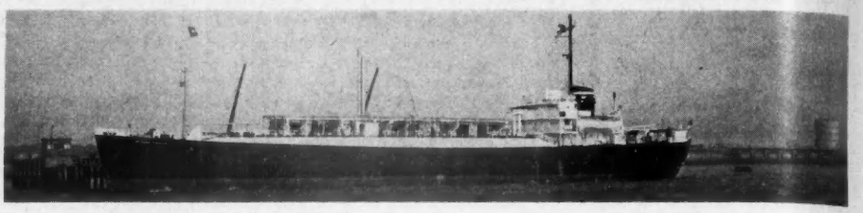
The graph also shows that there is little sign of a slowing down in the growth, except possibly for the Mechanicals—the largest of the institutions.



Growing membership of the four primary engineering institutions.

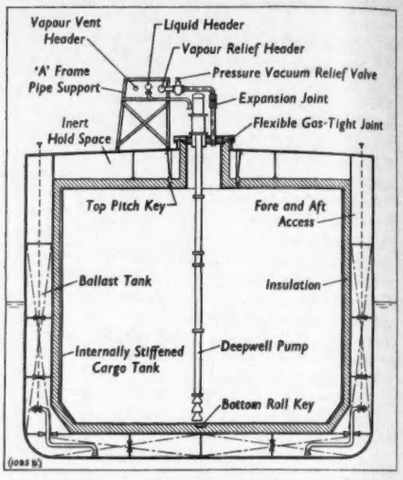
Transporting Low-Temperature Liquid Gas

Experience gained with the MV "Methane Pioneer" in low-temperature service has brought to light many factors which might influence the design of future vessels in this type of service.



(Above) The "Methane Pioneer" has lived up to its name in providing much useful information on the carriage of low-temperature liquid gases.

(Right) Typical section through the cargo tank of the "Methane Pioneer".



LAST week we published (p. 635) a few details of the liquid methane tankers which are to be built for the transportation of the gas to this country under the Gas Council's scheme.

At almost the same time as the Council made their announcement, a paper was presented in New York to the Society of Naval Architects and Marine Engineers on the subject of "Low Temperature, Liquefied-Gas Transportation" and much of the information contained therein has not hitherto been available. The authors were C. G. Filstead and Montgomery Banister, the former being with Conch Methane Services Limited of London.

The "Methane Pioneer," over seven trips between the Gulf of Mexico and Canvey Island, carried with complete success 2,000 tons of liquid natural gas each time, commencing operations in early 1959. The same Canvey Island installation is to be expanded and two tankers are to be built in Britain each having a capacity of about 12,000 tons of liquid methane to serve the installation from Algiers. Another tanker is at present being built in Japan for transportation between the Persian Gulf and Japan.

Basic Considerations

Liquefied gases have certain characteristics in common and these have important implications:

Low Boiling Point:—The retention of liquid gas stored at or near its boiling point (which is lower than ordinary ambient temperatures) requires insulation. The insulation may serve the secondary purpose of protecting materials, such as mild steel, which are adversely affected by low temperatures.

High Vapour Pressure:—Liquids in storage, whose boiling points are below ambient temperatures, will generally exhibit a vapour pressure equal to or greater than atmospheric, since the influx of heat is inevitable, there being no perfect insulation. This feature provides a measure of safety for such liquids in storage, since air will naturally be excluded from the storage vessel.

Low Density:—The densities of liquefied gases are generally lower than other liquid fuels such as gasoline. It can be said that the carriage of liquefied gases presents a problem of cubic to the designer; cargo deadweight will always be less than the vessel's dimensions would imply as compared with a conventional tanker.

It should be noted that the liquid gas density at ambient temperatures (as in pressure-vessel transportation) is lower than that of the same gas at its boiling point, placing even greater limitations on the cargo deadweight carrying capacity of a vessel carrying gas under pressure.

These basic considerations have led to the design of liquid gas tankers with large cubic capacity, divided into a number of insulated tank units, with cargo carried therein at its boiling point.

Layout of Tankers

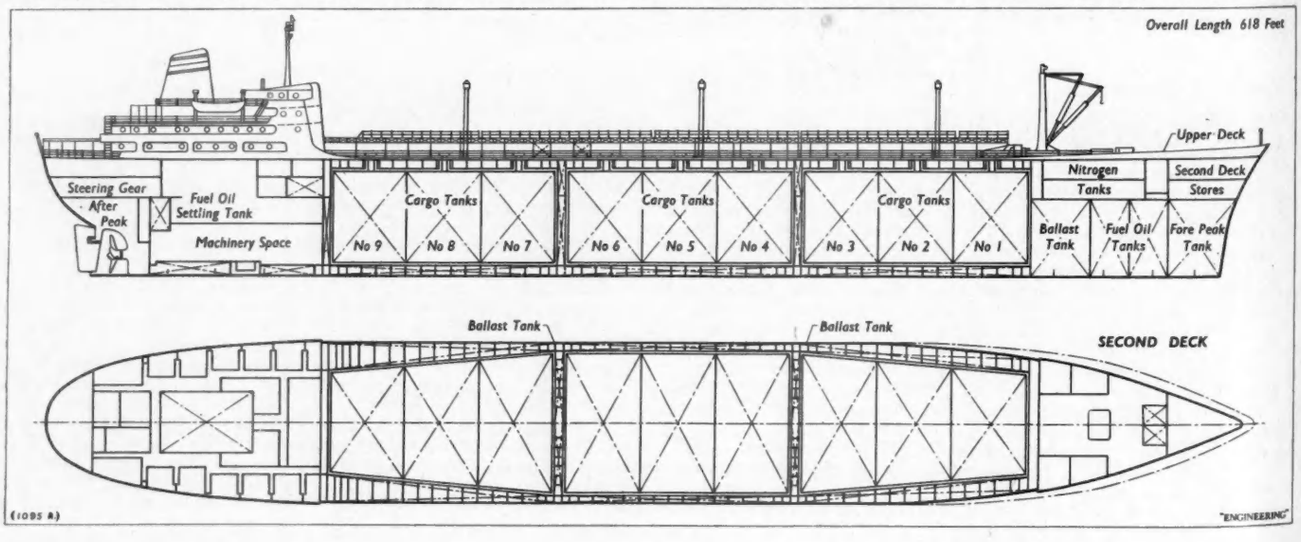
The arrangement of cargo spaces within the vessel needs special consideration. The importance of developing the maximum cargo cubic of the ship has already been stated. This is accomplished by arranging that the cargo tanks occupy as much of the beam, depth, and length of the ship as possible. The maximum utilization of beam is limited by depth of web or stringer as required to support structurally the vessel's sides.

It may be said that the depth of the vessel need not be a limiting factor to the size of the tanks since they can be extended above the weather deck in some sort of trunked arrangement. However, the tanks must be insulated, protected from the weather, equipped with flexible joints between tank and ship and provided with adequate working space on top. These requirements can best be met by carrying the vessel's sides above the depth of the tanks.

The maximum utilization of the vessel's length is first limited by the usual considerations of providing engine room and balancing buoyancy space at the bow. Location of the engine room at the stern is obviously the only practical answer. The fine section at the bow, which would be quite suitable for liquid cargoes carried against the shell, are more expensive to fit out with insulation and tanks.

Transverse bulkheads will be required at spaces not greater than 120 ft to divide the vessel into a number of holds. Since low-temperature cargo will be carried on both sides of some of these bulkheads, due consideration must be given to providing a path for replenishing the heat which is lost by the steel to the cargo. This path must be at least broad or short enough to permit heat from the sea or atmosphere to penetrate to the centre of the bulkhead in

Inboard profile and hold plan of 170,000 bbl liquid methane carrier. This is the same capacity as the two to be built in Britain for the Gas Council.



sufficient quantity to keep the bulkhead from dropping to unsafe brittle temperature. It has been found that the natural convection plus conduction within a double-skin bulkhead will accomplish this on a methane tanker.

Cargo holds contain the insulation and the cargo tanks. Insulation thickness may be established on an economic analysis. The construction procedure is to build and insulate the hold and later to install the separately built and tested tanks. It can be appreciated that clearance is essential as the cargo tanks will contract from their as-built dimensions to their operating temperature. This contraction is substantial for a large aluminium methane tank, being about 2 in per 50 ft.

It is found desirable to gain cargo cubic by making the tank depths as large as possible—consistent with adequate stability. This results in rather large vessel depths and consequently high freeboards, but this is a decided benefit to maintenance of the cargo-handling equipment and piping, all located on the weather deck.

The independent cargo tanks can best be accommodated in a vessel having U-shaped lines. V-shaped lines would require greater tank shape and magnify tank keying problems. Since the trade routes under consideration generally have good weather, U-shaped lines have been adopted for the two British tankers to be built and the Japanese one now in building.

The cargo tank designs considered have been constrained to contract about a point in the tank bottom located directly under the piping trunk. By this arrangement the motion at the top of the trunk, where piping connections are made, is restricted mainly to the vertical direction. The forces transmitted by the keys are derived from the weight of the tank and contents, being subjected to the motions and inclinations of the ship in operation. The detail design of keying must include load-bearing thermal insulation, which for the designs considered is about 6 in of laminated phenolic block taking loads in compression.

Disposal of Boil-off

Disposal of boil-off may be handled in several ways: (1) direct venting to atmosphere, (2) used as fuel and (3) reliquefaction.

For methane ships, the use of boil-off as fuel appears most desirable on an economic basis. This requires a dual-fuel engine, since the quantity of boil-off varies, particularly between the loaded voyage and the ballasted voyage. Dual-fuel propulsion may take the form of gas/oil burning boilers, or gas/oil diesel engines. It may also be feasible to employ gas-turbines on methane ships providing the dual-fuel feature can be accommodated.

TABLE.—*Particulars of Liquefied-Gas Tankers built or building.*

Name	"Methane Pioneer"	Unnamed	Unnamed
Builder	Conversion by Alabama DD Co.	Mitsubishi Japan	Vickers-Armstrongs and Harland & Wolff
Flag	British	Japanese	British
Trade	Lake Charles to Canvey Island	Kuwait to Japan	Algiers to to Canvey Island
Speed (knots)	10	16	17½
Hull characteristics (ft in):			
Length overall	338 8	603 2	618 0
Breadth moulded	50 0	82 0	81 6
Depth moulded to weather deck	41 0	54 9	58 6
Draught moulded	21 0	30 6	26 0
Ratios:			
Length/depth	7·8	10·48	9·83
Length/beam	6·4	7·0	7·05
Beam/depth	1·22	1·5	1·39
Draught/length	0·0656	0·0532	0·0452
Capacities:			
Liquid gas cargo bbl.	32,000	180,000	170,000
Ballast, tons, sea water	2,205	10,620	11,299
Fuel oil, total, tons	298·5	2,295	1,597
Cargo handling:			
No. of holds	2	4	3
No. of tank units	5	4	9
Machinery particulars:			
Shp (max continuous)	2,000	13,000	13,750
Type propulsion	Direct drive diesel	Direct drive diesel	Dbl reduction grd turbine

2,000 gpm from Fire Fighting Unit

Shortage of water in Hong Kong coupled with the highly inflammable shacks and houses in the congested squatters' quarters on the Island have made the acquisition by the fire brigade of powerful pumping appliances a top priority.

The use of sea water hydrants has proved extremely valuable and a pumping unit just completed by Merryweather will be capable of pumping 2,000 gallons per minute from the

Pump relay unit for Hong Kong.

sea through lengths of 4 in canvas hose to keep the island's emergency water tanks charged during a serious fire. These emergency tanks are strategically placed throughout the colony.

The appliance will also fulfil the role of a highly efficient fire fighting unit. For such work the machine has ten delivery outlets—five on each side—and two 4 in worm-gear monitors which are mounted forward of the pumping unit.

The self-contained two-stage high efficiency turbine fire pump is direct coupled to a Rolls-Royce diesel engine developing 230 bhp at 1,850 rpm. The chassis is a 16 ft 3 in wheelbase AEC "Mercury," with its own diesel engine developing 130 bhp at 2,200 rpm. The pumping set is mounted above the rear axle and is quite independent of the road engine. It embodies its own starting mechanisms both electric and hydraulic.

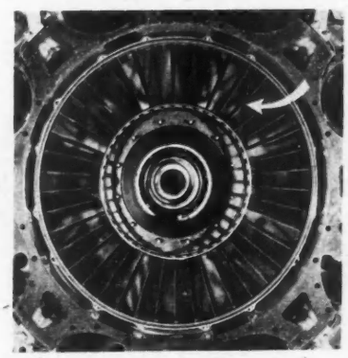
The pump is capable of delivering 2,000 gal per min at 100 lb per sq. in with variations down to 1,000 gal per min at 170 lb per sq. in.

Merryweather and Sons Limited, Greenwich High Road, London SE10.

Thin-Wall Tubes of Aerofoil Section

The Bristol Siddeley Proteus turboprop engine has behind it over two million hours in Britannia service alone and has in addition a remarkable record of reliability in other aircraft.

The strength, lightness and simplicity of



Thin wall tubes of aerofoil section are used for the compressor entry guide blade ring of the Proteus engine.

design of this engine are typified in the compressor entry guide blade ring which is made up of thin-wall, aerofoil section, stainless steel tubing, precision drawn. The tubes are 0·018 in thick, 0·925 in cross-sectional width and 4·720 in long.

Said to be stronger, more economical and more reliable to produce than blades produced by other methods, the tubes are filled with microcrystalline wax and moulded into aerosections in a 40 ton press. This is preceded by an internal copper-plating process which increases heat conduction of the warm compressor air passed through the aerofoil blades to prevent icing at high altitudes.

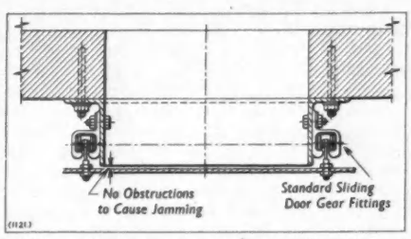
Fine Tubes Limited, Britannia Works, King Charles Road, Surbiton, Surrey.

Non-Sticking Sliding Gates for Hoppers

Designing gates for the mouths of hoppers and bunkers, particularly those working in a horizontal plane, has always been a problem because of sticking due to an accumulation of particles between the guides.

Many attempts have been made to overcome this trouble, perhaps the most successful being the single or double swinging clamshell type. Swinging gates, however, require more headroom than sliding gates and sometimes this is at a premium. This was the case in a row of 12 hoppers at the Swinden Laboratories of the United Steel Company.

On these hoppers, normal gates were dispensed with and the steel plate forming the gate was suspended from two pieces of trolley track



Sticking, due to an accumulation of particles in the guides, is avoided in this sliding hopper gate.

supplied by Coburn Engineers Limited. The track was the type normally used in buildings, and the construction can be seen in the illustration.

The opening of the hopper is 18 in square and it can be seen that dust and fines which may percolate between the mouth of the hopper and the closing plate have no obstruction against which to pack and the plate can be adjusted on the suspension bolts to close the gap to a minimum. On United Steel's hoppers, the gates were within 5 ft of the ground and easily accessible. Opening was by two roller chains, one on each side, operated by a ratchet spanner applied to one of the chain sprocket shafts. Levers, rack and pinion gears or power cylinders could be used in other situations.

Coburn Engineers Limited, Coburn Works, Peasmarsh, Guildford, Surrey.

Air Suspension for Trailers

Mr. J. L. B. Crane, sales director of Cranes (Dereham) Limited, said recently that an air suspension system using independent stub axles on trailing radius arms, thus combining all the advantages of the steel sprung trailing axle suspension with those of air suspension, had been fitted on a tanker in service in Nigeria. The object was to see if this suspension is suitable for severe conditions involving poor roads, high temperatures and an exceptional amount of fine dust. After six months, it is said to have given satisfactory service.

"A possibility for the future," said Mr. Crane, "is a combination of a steel spring with air suspension. This is simple to arrange and makes less demand on the air supply. The different frequencies of the two systems tend to damp one another out."

Cranes (Dereham) Limited, South Green Works, Dereham, Norfolk.

International Safety Standards Needed for Cranes

British crane manufacturers are said to be finding themselves at a serious disadvantage in world markets because of the differences in national safety standards.

This fact was made clear at a recent conference of the International Standards Organization Technical Committee 96, which dealt with cranes and excavators. Held at British Standards House in London, the object of the conference was to provide " standardization in the field of cranes and excavators particularly in respect of terminology, load rating, materials, design, stability, testing and safety."

Delegates visited the Letchworth works of K and L Steel Founders and Engineers Limited —one of the 600 Group of Companies—where they saw Jones mobile cranes undergoing various tests for static tipping, dynamic lowering, and braking.

The first test proved the stringency of British Standard procedure compared with that adopted in other countries. A Jones KL10-6 mobile crane, jacked and carrying a 10 per cent overload, was tested for tipping in accordance with British Standards. The crane was then tested to the requirements formulated by the Federation Europeane de la Manutention. The outrigger jacks were screwed down to lift the crane wheels off the ground, and under these conditions the working radius of the crane, with the same load, was increased by 18 in.

Dynamic lowering tests under full load followed. This was done in three ways: (*a*) controlled at idling speed, (*b*) controlled at maximum engine speed, and (*c*) lowering on brake at creeping speed. Under all these conditions the load was arrested in a distance of 10 per cent of the maximum lowering speed. There was, as expected, a large variation in the margins of stability. This showed once again that an international test procedure is essential not only from the safety aspect, but also to ensure that a minimum margin of stability can be guaranteed in accordance with a set test procedure.

Other tests included sensitivity of control and braking capabilities.

The George Cohen 600 Group Limited, Wood Lane, London W12.

Gas-Turbine Ship "Auris" Justified its Inception

The gas-turbine ship " Auris " was the subject of a paper recently presented to the Institute of Marine Engineers. In it, the authors, R. M. Duggan and A. T. O. Howell, gave some interesting facts about operating experience with the vessel.

Although the Auris is now laid up, this is due to the fact that 12,000 ton tankers are now obsolete as economic propositions rather than for technical reasons. The behaviour of the machinery well justified the early expectations and as an experimental unit it has completely justified its inception. Lack of time and falling freight rates prevented its commercial acceptance. The three installations in Auris took place over ten years—being four diesel engines, followed by part gas-turbine and diesel electric propulsion, eventually followed by a single gas-turbine—and, although this may appear a long time, when she entered commercial service in 1959, she was propelled by a completely new engine which would compete well with a steam turbine of similar power.

The rather later decision to install the single 5,500 bhp gas turbine meant that certain design features had to be accepted which would otherwise have been avoided. Examples of this are the left handed propeller, the distance between shaft centre lines and the retention of a Scotch cylindrical boiler.

The Auris machinery was a prototype, and it was a remarkable achievement that it was installed and ran in a ship without any shore testing. The initial cost appeared high compared with normal commercial ships' machinery, often well tried and simply tailored to suit the ship in question. Compared with prototype gas-turbine engines in the aircraft industry the cost was a fraction.

Designs for the next stage of gas-turbine machinery show that instead of just breaking even with steam machinery of comparative power, they would be distinctly ahead even with conservative temperatures. The authors considered that the Auris is only the second stage in the development of marine gas-turbines. Steam turbines have their distortion, boiler and evaporator troubles; diesel engines have cylinder liners and lubricating oil bills. Both are on their limits of design and the gas-turbine is just beginning.

Advantages over Hydrofoils Claimed for New Craft

A craft embodying in its design the planing principle of the hydrofoil and gaining a proportion of its lift from the air pressure built up under the concave hull was recently demonstrated to ENGINEERING in Poole Harbour, Dorset.

Called the " Skydrofoil," this 45 ft boat resembles, at rest, a conventionally designed craft of fine lines, but at planing speed it rises some 18 in out of the water on to what is known as a " Skie-Stabiliser." This is a device under the bow of the craft which automatically submerges the minimum surface at the most efficient angle to lift the forefoot clear of the water and maintain the hull at a fixed angle.

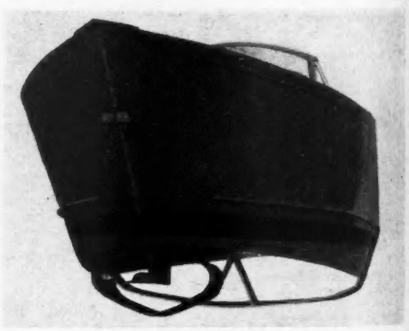
The designer of the Skydrofoil, Mr. Brian Grimston, estimates that the craft only requires half the power of the fastest known planing launches of similar size, and the power curve is said to rise smoothly from the start without having to cross the " hump " encountered in the curve of normal boats and hydrofoils.

The concave underwater lines make the craft very stable when stationary or under way, and the passage is smooth with little wake being produced. The designer claims that the energy expended by normal craft in pounding up and down is saved and converted into a shock absorbing forward motion by the action of the self-inclining stabilizer at the bow.

Hydrofoils usually need a large draught with resultant problems of special landing stages and complex transmission arrangements. On the Skydrofoil the draught is only 2 ft 3 in at rest. Designed as a prototype for patrol boats, ferries and yachts and to confirm designs for the construction of larger craft to carry 120 passengers at speeds above 20 knots, the present craft has space for 30 to 40 passengers.

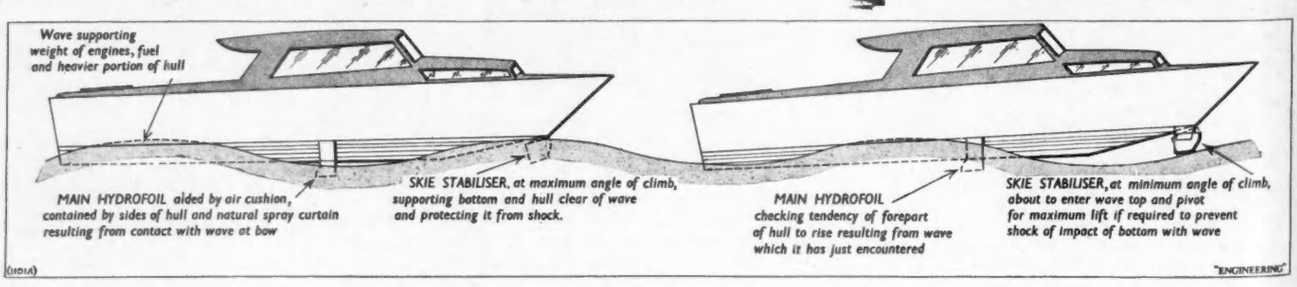
It is of aluminium construction and is powered by two Perkins S6M diesel engines. The " Skie-Stabiliser " is available in three sizes for ordinary planing launches up to 40 ft long. Transverse framing with identical frames makes the Skydrofoil suitable for quantity production and permits a strength-to-weight ratio unobtainable by other hulls.

Brian G. Grimston and Partners, Dorset Lake Shipyard, Hamworthy, Poole, Dorset.



(Right) In this view the " Skie-Stabiliser " can be seen under the bow, the main hydrofoil half-way along the hull, and the concave bottom.

(Below) The principle of the "Skydrofoil" is based on the lift obtained by the " Skie-Stabiliser " under the bow and the air cushion under the concave hull.


Wave supporting weight of engines, fuel and heavier portion of hull
MAIN HYDROFOIL aided by air cushion, contained by sides of hull and natural spray curtain resulting from contact with wave at bow
SKIE STABILISER, at maximum angle of climb, supporting bottom and hull clear of wave and protecting it from shock.
MAIN HYDROFOIL checking tendency of forepart of hull to rise resulting from wave which it has just encountered
SKIE STABILISER, at minimum angle of climb, about to enter wave top and pivot for maximum lift if required to prevent shock of impact of bottom with wave
(1/104)
"ENGINEERING"

Submerged Fuel Pump Prevents Vapour Locks

The prevention of vapour locks in automobile fuel systems is a problem which has become prominent with the advent of high volatility fuels, coupled with the growing use of motor vehicles in all parts of the world. Vapour locking is particularly troublesome on the suction side of a fuel system. It follows, therefore, that a most effective counter measure is to locate a pump below the surface of the fuel tank. When located thus, no vacuum can occur on the intake side of the pump which, being gravity fed with liquid fuel, can maintain its rated pressure on the delivery side. This is the working principle of a new Lucas electric fuel pump—the model 2FP.

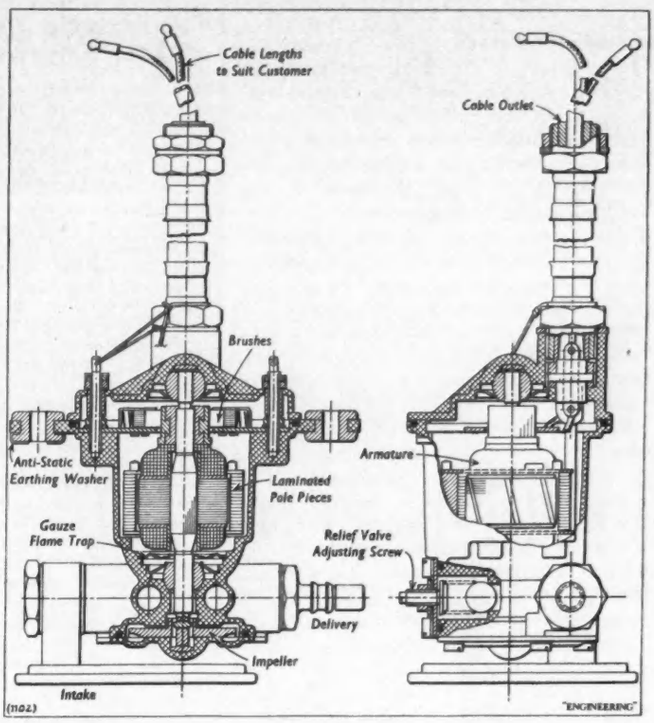
The Lucas pump is a composite unit containing, within a single body and between two end covers, an electric motor and a cumulative type centrifugal pump. The body end covers are zinc pressure die castings while an integrally mounted foot provides two hole fixing of the unit through two petrol proof rubber grommets. An earthing washer on one of the fixing bolts provides an earthing path from the pump unit to its mounting bracket, so preventing the build-up of electrostatic charges on the unit. The pump is fully sealed and suitable for mounting either in the fuel tank or adjacent to it.

The insulated-return motor has a high energy permanent magnet field system for simplicity, reliability and robustness. A twin-cored pvc covered supply cable passes from a sealed terminal moulding in the motor and through a petrol-proof outlet union. When the unit is mounted inside the fuel tank, the cable passes through armour-braided tubing and is brought out of the tank through a petrol proof gland.

The pump, being cumulative and having both intake and delivery ports at the periphery of the impeller, develops more pressure than a conventional centrifugal pump. A moulded fluted impeller floats axially on the motor armature shaft and is driven by a cross peg in the shaft. Both the armature shaft and peg are of stainless steel. The motor runs at about 3,000 rpm according to the voltage and load. An adjustable relief valve consisting of a stainless steel ball and spring, is provided in the pressure chamber and may be adjusted to suit the particular requirements of the vehicle concerned.

In operation, the whole of the interior of the unit, including the commutator and brush gear of the motor, is flooded with fuel, but since there is no projecting shaft, no troubles associated with running seals can arise.

The arrangement of the Lucas 2FP submersible fuel pump. The unit may be situated inside the fuel tank or adjacent to it. Features of its design are prevention of vapour locks and higher pressures possible than previously with conventional pumps.



When the pump is running, fuel passes through the armature bearing at the pump end of the unit, into the motor chamber and thence through a return passage to the pump intake port. This continuous circulation obviates stagnation of fuel in the motor portion.

If the tank is allowed to run dry with a system having the unit mounted inside the tank, re-priming of the pump is expedited by the provision of a bleed hole in the pump body casting near the outlet port. A small continuous discharge occurs while the pump is running. Pumps mounted externally to the tank have to be fitted so that the inlet port is always below the lowest fuel level and no bleed is then necessary.

When the motor is flooded with fuel there is no possibility of the fuel's igniting, but, even should the tank become empty and the fuel drain away from the motor, the vapour in the casing would normally be far too rich to ignite, due to the narrowness of the ignitable range of petrol/air mixtures. However, if conditions do arise which allow ignition to occur, the only communication with the pump portion of the unit is either through the bearing, whose small clearance constitutes a flame trap, or via the circulation return passage which, being of small bore and relatively great length, also serves as a flame trap. To cover the possibility of a bearing having developed a large clearance (this does not normally occur) a gauze flame trap is incorporated between the armature and the bearing. An additional safeguard is provided by a 200-mesh filter connected to the intake port which is the only outlet to the fuel tank.

Although the possibility of ignition is remote, the measures described serve to stifle and render innocuous any ignition which might occur if the unit should become filled with a suitably susceptible mixture of fuel vapour and air from an empty tank.

Measuring Acceleration for Fuel Consumption Studies

Motoring has never been an inexpensive pleasure but as the cost continues to rise, fuel consumption and economy become increasingly important to the discriminating motorist anxious to obtain the most value for money. Fuel consumption depends on many variables of which perhaps the most significant is speed—at constant speed, consumption is, on the average, almost double at 80 mph what it is at 40 mph. Rate of acceleration is also a very large contributory factor which is now being examined at the Thornton, Cheshire, Research Centre of "Shell" Research Limited.

An instrument that detects and records changes in a vehicle's speed occurring in a thousandth part of a second has been designed by engineers at the research centre.

The need for an accelerometer of this sensitivity became apparent during recent studies at Thornton of the comparative performances of various motor fuels. In measuring the acceleration of cars using these fuels it was found that the driver's reaction to their performance did not agree with the measurements made by observers using stop watches.

The instrument developed at Thornton can measure the acceleration of the vehicle itself or the acceleration of the engine. These two accelerations are not necessarily identical, as any driver knows especially one who has driven a car fitted with automatic transmission.

A fifth wheel forms part of a device developed at the "Shell" Research Centre, Thornton, for measuring with great accuracy the acceleration of a car on the road. Revolutions of the wheel are recorded on a paper tape.

To measure the acceleration of the car a fifth wheel is used. This is a bicycle wheel attached to the rear bumper. The time for each revolution of this extra wheel—only a few thousandths of a second—is automatically measured by the accelerometer and recorded on a paper tape. From this tape it is a simple matter to calculate the change of speed or acceleration.

When the engineers are measuring the acceleration of the engine, they connect the accelerometer electrically to the contact breaker of the car's distributor. The tape then records the time, again in milliseconds, of each revolution of the engine.

In both cases the tape simultaneously prints a running record of the time elapsed since the acceleration began. In this way acceleration at any time during the speed change can be determined.

It might appear, at first sight, that variations of milliseconds cannot mean very much in terms of engine performance. But in fact it is found that the smallest differences are of paramount importance in the study of the significant changes in fuel composition under operating conditions.

Plain Words

By Capricorn

THERE is about the words "heretic" and "heresy" something medieval (or communistic). They are words plucked from earlier, violent times, uncongenial in our own tolerant, indifferent times. Yet when I hear them I instantly take notice because I'm sure there are many heresies round about us but we are too blind to see them.

Sir Lindor Brown recently questioned the widely accepted objections to the duplication of research effort, when he gave his presidential address to the Institute of Information Scientists. He said that on two occasions he had discovered the same phenomenon and analysed it by the same methods as two of his friends in other countries. On each occasion they both reached the same conclusions, but—and this is where Sir Lindor challenged the validity of the usual objections to duplication—the end results of their research were quite different. From identical conclusions they made different deductions and pursued different secondary aims. "A discovery," he said, "may well be a landmark, but the directions it bears for further travel point to many roads, and two people seldom follow the same one." In his view, duplication of effort is desirable, because without it informed criticism dies, the stimulus of competition is annulled, and the dynamic force generated by the desire to show old so-and-so what a fool he is, is lost. "Don't forget," he reminded the information scientists, "that we owe Newton's *Principia* in part at least to an urge to show that Descartes was wrong."

Sir Lindor Brown is surely right to stress the positive value of duplication of effort, and although he is a physiologist and was speaking of science, his remarks can as well be applied to the art and science of engineering. He is aware that heresies in scientific belief would multiply and be perpetuated if there were not reasonable freedom for people to work in parallel—known or unknown to each other—on the same subject. To forbid duplication is a heresy of the worst possible kind because it would effectively protect all scientific knowledge from disturbing criticism.

I remember attending a meeting of the Institution of Civil Engineers when the late Oscar Faber presented his new theory for determining the safe bearing load of piles. Having observed then just how fierce engineers can become when their accepted beliefs and practice are challenged, I am in no doubt that engineers will always be ready to argue the pros and cons of a theory from their experience of the practice of their profession. Theory is a basic tool in their work, but they have a healthy scepticism for theories which do not fit in with their observations on the site or in the works.

If there are any engineers with Sir Lindor's capacity for rooting out heresies, I wish they would speak out and save us from the deadening effect of dull conformity.

Letters to the Editor

"Fantastic Reliability" of Car Engines

SIR, I am surprised that my friend, Mr. A. M. Gunner, is able to say that after 5,000 miles "gearbox and axle oils always come out clean" (ENGNG., 3 Nov. '61, p. 570).

This assumes an unbroken perfection of gear profiles and oil film between gear teeth throughout every revolution, at all operating temperatures and pressures, with condensation, and during the many reversals that take place in 5,000 miles. This assumption carried to its conclusion implies that state of perfection in which no wear ever takes place on gear teeth or on the rotating and sliding surfaces of gearbox and axle members.

I recall drinking apparently clean water at a certain continental resort with rather unpleasant after-effects and I would prefer not to assume that my car oil is as clean as appearances may lead me to believe.

My experience with anti-freeze (not blue can) has been less fortunate than that of Mr. Gunner. Some years ago, I had the misfortune to "dissolve" the radiator core of an old but expensive model car while in Switzerland, and the cost of a hand-made replacement has persuaded me that the winter use of anti-freeze is a necessary evil, not to be extended over periods when the necessity does not exist.

Like Mr. Gunner, I have no fault to find with the air in my tyres, but, again, I am surprised that his seven-year-old model was fitted with tubeless tyres.

My remarks are not intended to detract anything from claims for "fantastic reliability" but perhaps to suggest that it is, in part, due to the proper treatment at the right time.

Yours faithfully,
A. H. L. TRAPNELL.

Box, Chippenham,
Wiltshire.
14 November, 1961.

SIR, May I comment on Mr. A. M. Gunner's letter (ENGNG., 3 Nov. '61, p. 570), on the article by Mr. Gordon Wilkins on "Engine Changes in Britain and Abroad" (20 Oct. '61, p. 502)?

I agree that the modern motor can be a very reliable machine and is good value for money, but people are inclined to forget the tax, and a lot of luck and driver behaviour enters into it. It is even known for a poor car to come off the production line and to go out as such—nothing being done about it because is was not economical—until the poor owner eventually complained. A particular case on record concerns a new car which had £350 spent upon it, just over a third of its cost.

However, with regard to oil changing, this is a controversial problem. I do not agree that the gearbox and back axle come out clean at the normal change time. Careful inspection of the former, even without the aid of a microscope, shows finely divided bronze from the synchromesh rings. Once this is in the oil, does it not become a fine grinding compound, thus accelerating wear?

The antifreeze can certainly be left in, but does require topping up each winter, for its efficiency decreases quite considerably in twelve months. Some tests done after this period on antifreeze from the "same colour of can" showed a marked rise in the freezing temperature, and in one case the margin of safety after twelve months was nil.

Tyre wear depends upon the threefold factor of driving style used, the tyre itself, and the car. The results, therefore, differ widely; with tubeless tyres giving, for reasonably driven vehicles, 17,000 to 27,000 miles, tube tyres somewhat better than this, and finally, steel breaker tyres giving probably the greatest mileage consistently.

Finally, with due respect to Mr. Gunner, 28,000 miles in seven years is very gentle motoring with adequate time for cleaning and maintenance. There are those who do this amount and more in the space of one year which could entail much more wear and tear, while the average owner driver does about 10,000 miles per year.

Yours faithfully,
T. ISHERWOOD.

Whitley Bay, Northumberland.
15 November, 1961.

Completion of the Tamar Bridge

SIR, The article "Tamar Bridge Completed" (ENGNG., 3 Nov. '61, p. 573) has just come to my notice and I wish to draw attention to an incorrect statement at the end of paragraph 3, column 2, of this article.

It is stated there that "The ropes were made by British Ropes Limited of Doncaster and are of the locked coil pattern, a type of rope not known to have been previously used in suspension bridge construction."

In 1931, I was on the staff of Rendel Palmer and Tritton, consulting engineers, London, and I was engaged on making an independent set of stress calculations for the new Chelsea suspension bridge, the basic design and original stress calculations having been made by Mr. J. R. H. Otter, now a partner in that firm.

As a result of Mr. Otter's investigations of the strain properties of various types of rope, it was decided to use locked coil ropes and, moreover, a system of prestressing the ropes was used to mark them for erection purposes to ensure a full distribution of load between the component ropes of the 37 rope cable, and so that they might have the maximum effective modulus of elasticity under working conditions. A technique of coiling these ropes on large diameter drums at works was evolved, to reduce to a minimum the loss of prestress when erected at site.

I should also point out that the Cologne self-anchored suspension bridge, built some time earlier than the Chelsea bridge also incorporated locked coil ropes.

Yours faithfully,
A. H. TOMS,
Research Assistant to the Chief Civil Engineer.

Southern Region,
British Railways, London SE1.
13 November, 1961.

New Formulae for Oil Flow in Pipelines

SIR, Dr. J. S. Blair does himself less than justice in his article entitled "New Formulae for Oil Flow in Pipelines" (ENGNG., 10 Nov. '61, p. 603) as his graphical solution is certainly not limited to oil, nor indeed, to pipelines.

Reference to a textbook of chemical and physical properties, such as Kaye and Laby, will give the kinematic viscosity of most fluids from which can be deduced the Reynolds number and, thus, a solution for any fluid selected. If, in addition, Dr. Blair substitutes 4 M for D in the Darcy formula (where M = the hydraulic mean depth) his solution is then applicable to circular pipes running less than full, pipes of non-circular section running full or less than full, and also for parallel open channels of any cross section.

Dr. Blair is no doubt aware that this type of solution by Ernst was published with a nomograph in *The Engineer* dated 5 July, 1946, and entitled "Frictional Pressure Loss Nomogram." I would also refer him to a paper by Bull entitled "The Flow of Fluids in Pipes," published in *Practical Engineering* of 29 March, 1946. Chapter XII of Lewitts' book *Hydraulics* (Pitman) confirms Dr. Blair's experimental values of f.

Yours faithfully,
JOHN A. BUBB.

Navy Works Department,
HM Dockyard, Portsmouth.
15 November, 1961.

Events in Advance

Functions of the Education Officer

ARRANGEMENTS have been made by the London and Home Counties Group of the British Association for Commercial and Industrial Education to hold a whole-day conference (10.30 a.m. to 4.30 p.m.) for discussing "The Role and Function of the Education and Training Officer."

This subject has been receiving the attention of a special study group of the London and Home Counties Group and, in July last, a questionnaire was circulated to all members, to which more than 70 replies were received. The morning session of the forthcoming conference will accordingly be devoted to a report on the results of an examination of these answers.

In this connection, three papers will be read: "Headquarters' Organization in Education and Training," by Mr. F. C. Hayes, of the Joint Iron Council, who will also act as chairman of the conference; "The Education and Training Officer in Engineering," by Mr. G. H. Huxford, of D. Napier and Son Limited; and "Education and Training in Service Organizations," by Mr. F. H. Goldsmith, of the General Post Office.

Two papers will be read in the afternoon: "The Process and Problems of Professionalization," and "The Role and Function of the Education and Training Officer—A Personal View." The author of the former paper has not yet been finally chosen, but the second paper will be presented by Mr. J. A. Hunt, M.B.E.

The meeting will take place at Caxton Hall, off Victoria Street, London SW1, on Tuesday, 5 December. A conference fee of £1 10*s* is payable, to include a buffet lunch and certain other refreshments. Application forms and further particulars are obtainable from the Group's honorary secretary: Mr. T. H. J. Field, British Road Services, Melbury House, Melbury Terrace, Marylebone, London NW1.

Meetings and Papers

The address and telephone number of the headquarters of each institution are given at the end of this list. Meetings in the headquarters town are held there unless otherwise stated.

British Association for Commercial and Industrial Education

LONDON
"The Role and Function of the Education and Training Officer"; Discussion. London and Home Counties Group. Caxton Hall, off Victoria Street, SW1. Tues., 5 Dec., 10.30 a.m. to 4.30 p.m.

British Institution of Radio Engineers

LONDON
"Possible Uses of Computers in Medical Diagnosis"; Discussion, to be introduced by Dr. A. D. Booth. Joint Meeting of Computer and Medical Electronics Groups. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 6 Dec., 6 p.m.

CARDIFF
"Microwave Valves," by R. W. White. South Wales Section. Welsh College of Advanced Technology, Cardiff. Wed., 6 Dec., 6.30 p.m.

LEICESTER
"Transistors in Computers and Control Equipment," by P. James. East Midlands Section. The University, University Road, Leicester. Wed., 6 Dec., 6.45 p.m.

MANCHESTER
"Radar for Civil Aviation Purposes," by K. F. Slater. North Western Section. College of Technology, Manchester. Thurs., 7 Dec., 7 p.m.

British Interplanetary Society

BIRMINGHAM
"Economic Advantages of Astronautical Research," by L. W. Steines. Midlands Branch. Birmingham and Midland Institute, Paradise Street, Birmingham. Sat., 9 Dec., 6.30 p.m.

Combustion Engineering Association

MANCHESTER
"Liquid Petroleum Gas: the Present and Future Position in the United Kingdom," by R. B. Cutts. North Western Region. Engineers' Club, Albert Square, Manchester. Tues., 28 Nov., 2.30 p.m.

Engineers' Guild

LONDON
Annual General Meeting. Grosvenor Hotel, SW1. Wed., 6 Dec., 5.45 p.m.

Illuminating Engineering Society

MANCHESTER
"Fundamental Principles of Street Lighting," by C. S. Bayliffe. Manchester Centre. Offices of the North Western Electricity Board, Town Hall Extension, Manchester 2. Thurs., 7 Dec., 6 p.m.

NEWCASTLE UPON TYNE
"The Use of Coloured Light," by J. W. Bessant. Newcastle upon Tyne Centre. The Percy Building, King's College, Queen Victoria Road, Newcastle upon Tyne 1. Wed., 6 Dec., 6.15 p.m.

NOTTINGHAM
"The Society's New Code," by A. Roberts. Nottingham Centre. Electricity Centre, Carrington Street, Nottingham. Thurs., 7 Dec., 6 p.m.

Institute of Marine Engineers

LONDON
"Marine Diesel Engines," by E. W. Cranston. Student Lecture. Mon., 4 Dec., 6.30 p.m.

LEEDS
"Interesting Investigations," by J. H. Milton. North Midlands Section. At works of Yorkshire Imperial Metals Ltd., Leeds. Tues., 5 Dec., 7.15 p.m.

LIVERPOOL
"Metallurgy in Marine Engineering," by Dr. J. E. Garside. Junior Lecture. Merseyside and North Western Section. Riversdale Technical College, Aigburth, Liverpool 19. Wed., 6 Dec., 6 p.m.

Institute of Metals

BIRMINGHAM
"Stress-Temperature Relaxation of Springs," by R. Haynes. Birmingham Local Section. College of Advanced Technology, Gosta Green, Birmingham. Thurs., 7 Dec., 6.30 p.m.

Institute of Petroleum

LONDON
"Charge Relaxation in Hydrocarbon Liquids Flowing Through Conducting and Non-Conducting Pipes," by Dr. J. A. Carruthers and K. J. Marsh; and "Estimation of Electrostatic Potentials, Fields, and Energies in a Rectangular Metal Tank Containing Charged Fuel," by K. J. Wigley and Dr. J. A. Carruthers. Wed., 6 Dec., 5.30 p.m.

Institute of Refrigeration

LONDON
"Developments in Storage of Fruits," by Dr. J. C. Fidler. Institute of Marine Engineers, 76 Mark Lane, EC3. Thurs., 7 Dec., 5.30 p.m.

Institution of Agricultural Engineers

LONDON
"Agricultural Engineering Problems in Australia," by Professor A. H. Willis. Cromwell Hall, Earls Court, SW5. Wed., 6 Dec., 4 p.m.

Institution of Civil Engineers

LONDON
"The Wales Empire Pool, Cardiff," by E. C. Roberts and J. R. Kell. Tues., 5 Dec., 5.30 p.m.
"The Most Appropriate Training for a Railway Civil Engineer"; Discussion, to be introduced by A. H. Cantrell, Sidney Stevens and H. Mallinson. Thurs., 7 Dec., 5.30 p.m.

Institution of Electrical Engineers

LONDON
"Domains and Domain Patterns," by Professor L. F. Bates. Measurement and Control Section. Tues., 5 Dec., 5.30 p.m.
"Teaching Protective Systems"; Discussion, to be introduced by G. Heywood. Education Discussion Circle. Wed., 6 Dec., 6 p.m.
"Magnetohydrodynamics," by Professor M. W. Thring. Parsons Memorial Lecture. Thurs., 7 Dec., 5.30 p.m.
"The Peltier, Hall and Seebeck Effects"; Discussion. Medical Electronics Discussion Group. Fri., 8 Dec., 6 p.m.

BIRMINGHAM
"Banana-Tube Display Systems: A New Approach to the Display of Colour-Television Pictures," by Dr. P. Schagen. South Midland Centre. College of Technology, Birmingham. Mon., 4 Dec., 6.30 p.m.

BRADFORD
"Potentialities of Artificial Earth Satellites for Radiocommunication," by W. J. Bray. North Midland Centre. Bradford Institute of Technology, Bradford. Tues., 5 Dec., 6.30 p.m.

BRIGHTON
"The Protection of High-Voltage Insulators from Power-Arc Damage," by Dr. A. E. Guile. Southern Centre. Offices of the South Eastern Electricity Board, 10 Queen's Gardens, Hove, Brighton. Wed., 6 Dec., 6.30 p.m.

HULL
"Electricity in the Chemical Industry," by P. McDermot. North Midland Centre. Offices of the Yorkshire Electricity Board, Ferensway, Hull. Thurs., 7 Dec., 6.30 p.m.

LIVERPOOL
"Simulation of Intelligence," by Professor D. M. MacKay. Mersey and North Wales Centre. Royal Institution, Liverpool. Mon., 4 Dec., 6.30 p.m.

WEYMOUTH
"The Banana-Tube Display System: A New Approach to the Display of Colour-Television Pictures," by Dr. P. Schagen. Southern Centre. South Dorset Technical College, Weymouth. Fri., 1 Dec., 6.30 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Modern Harbour and Coastal Tugs," with films, by R. Beattie. Wed., 6 Dec., 6.30 p.m.

Institution of Heating and Ventilating Engineers

MANCHESTER
"Some Important Aspects of Oil-Firing as Applied to Sectional and Shell Boilers," by N. Charlesworth. Manchester Branch. Engineers' Club, Albert Square, Manchester. Fri., 8 Dec., 6.30 p.m.

NEWCASTLE UPON TYNE
"Experience in America of Heating and Air-Conditioning Practice," by C. S. K. Benham. Neville Hall, Westgate Road, Newcastle upon Tyne. Tues., 5 Dec., 6.30 p.m.

Institution of Mechanical Engineers

LONDON
"Can Plastic Components be Designed Rationally?" Discussion. Applied Mechanics and Theory of Materials of Construction Group. Mon., 4 Dec., 6 p.m.
"Lubrication Oil Filter Testing," by K. E. Buckman and S. W. Kemp; and "A Standard Contaminant for Oil Filter Testing," by A. T. Weare. Lubrication and Wear Group. Wed., 6 Dec., 6 p.m.
"Small Industrial Steam Plant"; Discussion. Steam Plant Group. Thurs., 7 Dec., 6 p.m.

CHESTER
"Blaenau Ffestiniog and Other Medium-Head Pumped Storage Schemes in Great Britain," by H. Headland. North Western Branch. Blossoms Hotel, Chester. Tues., 5 Dec., 6.30 p.m.

CHESTERFIELD
"The Hovercraft," by C. J. Thomson. East Midlands Branch. College of Technology, Chesterfield. Thurs., 7 Dec., 7.15 p.m.

HARLOW
"Application of Photoelastic Methods to the Solution of Engineering Problems," by C. Snell. Eastern Branch. College of Further Education, Harlow. Thurs., 7 Dec., 7.30 p.m.

MANCHESTER
"Machine Tool Research, Design and Utilization," by Dr. D. F. Galloway. James Clayton Lecture. North Western Branch. Literary and Philosophical Society, George Street, Manchester. Thurs., 7 Dec., 6.45 p.m.

MIDDLESBROUGH
"The Bearing of Psychology and Medicine on Engineering," by Sir Frederic Bartlett. North Eastern Branch. Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough. Tues., 5 Dec., 6.15 p.m.

NEWCASTLE UPON TYNE
"The Bearing of Psychology and Medicine on Engineering," by Sir Frederic Bartlett. North Eastern Branch. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 4 Dec., 6 p.m.

Institution of Polish Engineers

LONDON
"Management Training in the Armed Forces and in Industry," by E. A. Cooper-Key. 55 Princes Gate, Exhibition Road, SW7. Tues., 5 Dec., 7 p.m.

Institution of Production Engineers

LONDON
"The Assistance the Production Engineer Can Obtain from the Cost and Finance Accountant," by J. F. Hull. 4 Hamilton Place, W1. Thurs., 7 Dec., 7 p.m.

Institution of Structural Engineers

PLYMOUTH
"Site Production and Placing of Concrete," by R. J. Tatt. South Western Counties Section. Duke of Cornwall Hotel, Plymouth. Fri., 8 Dec., 6 p.m.

Junior Institution of Engineers

LONDON
"Development of a Modern Interceptor Aircraft," by A. F. Atkin. Fri., 8 Dec., 7 p.m.

Newcomen Society

LONDON
"Early History of Portland Cement," by Dr. P. E. Halstead. Wed., 6 Dec., 5.30 p.m.

Royal Institution

LONDON
"Restless Atoms in Solids," by Professor Dame Kathleen Lonsdale. Fri., 8 Dec., 9 p.m.

Royal Institution of Chartered Surveyors

LONDON
"Post-War Developments: The Location of Major Projects in England and Wales," by Dr. E. C. Willatts. Mon., 4 Dec., 5.45 p.m.

Royal Society of Arts

LONDON
"Overseas Marketing," by Roger Falk. Mon., 4 Dec., 6 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"Chemical Separations and the Use of Solvents," by W. E. Clarke. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 5 Dec., 7 p.m.

Society of Instrument Technology

BIRMINGHAM
"Instruments in Clinical Chemistry," by N. Crawford; and "Electronics in Surgery," by R. Lightwood. Midland Section. Gosta Green College of Technology, Aston Street, Birmingham. Fri., 8 Dec., 7 p.m.

Southampton Metallurgical Society

SOUTHAMPTON
"Fatigue," by T. R. G. Williams. The University, Southampton. Thurs., 14 Dec., 7.15 p.m.

British Association for Commercial and Industrial Education. Apply to T. H. J. Field, British Road Services, Melbury House, Melbury Terrace, Marylebone, London NW1. (PADdington 1161)
British Institution of Radio Engineers, 9 Bedford Square, London WC1. (MUSeum 1901)
British Interplanetary Society, 12 Bessborough Gardens, London SW1. (TATe Gallery 9371)
Combustion Engineering Association, 20 Jermyn Street, St. James's, London, SW1. (WHItehall 5536)
Engineers' Guild, 201 High Holborn, London WC1. (HOLborn 1057)
Illuminating Engineering Society, 32 Victoria Street, London SW1. (ABBey 5215)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London EC3. (ROYal 8493)
Institute of Metals, 17 Belgrave Square, London SW1. (BELgravia 3291)
Institute of Petroleum, 61 New Cavendish Street, London W1. (LANgham 3583)
Institute of Refrigeration, New Bridge Street House, New Bridge Street, London EC4. (CENtral 4694)
Institution of Agricultural Engineers, 6 Queen Square, London WC1. (TERminus 0140)
Institution of Civil Engineers, Great George Street, London SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London WC2. (COVent Garden 1871)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow C2. (Central 5181)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London SW1. (SLOane 3158)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London SW1. (WHItehall 7476)
Institution of Polish Engineers, 5 Princes Gardens, London SW7. (KNIghtsbridge 2363)
Institution of Production Engineers, 10 Chesterfield Street, London W1. (GROsvenor 5354)
Institution of Structural Engineers, 11 Upper Belgrave Street, London SW1. (SLOane 7128)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London SW1. (VICtoria 0786)
Newcomen Society, Science Museum, Exhibition Road, London SW7. (KENsington 1793)
Royal Institution, 21 Albemarle Street, London W1. (HYDe Park 0669)
Royal Institution of Chartered Surveyors, 12 Great George Street, London SW1. (WHItehall 5322)
Royal Society of Arts, John Adam Street, Adelphi, London WC2. (TRAfalgar 2366)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865)
Society of Instrument Technology, 20 Queen Anne Street, London W1. (LANgham 4251)
Southampton Metallurgical Society. Apply to Mr. S. W. Hallwood, Folland Aircraft Limited, King's Avenue, Hamble, Hampshire.

Human Element

Goodbye to the Wage Pause?

THE impotence of the wage pause is being more widely demonstrated. BEA's baggage loaders at London Airport (ENGNG., 17 Nov., p. 640.) have now more than won their point, being given 10*d* more per week than the sum for which they were striking. The electricity power workers have been granted an increase to take effect from the 28 January. Thus, the moratorium on wage increases has now been breached so widely that no one is likely to expect it to have much further value, even if the Prime Minister has had the Electricity Council on the mat.

With reference to the power workers, the alternative to the breaching of the pause might well have been to lose many of the workers. In April, the Ministry of Labour quoted the following average weekly earnings for male workers: shipbuilding, £15 4*s*; chemicals and allied industries, £15 12*s* 8*d*; engineering and electrical, £15 19*s* 7*d*; metal manufacture, £16 11*s* 8*d*; motor industry, £18 4*s* 1*d*. At the same time, workers in the electricity, gas and water industries were quoted as earning a much lower average of £13 18*s* 9*d*.

Cabinet ministers might declaim that "the wages pause is one of the facts of life" but they are overlooking the really relevant fact of industrial life that joint consultation and negotiation are the only methods of settling claims that have the confidence of both sides of industry. To parody what Gladstone said about Naples, the wage pause is the negation of consultation erected into a system of industrial government. To negate such a widely respected institution is a dangerous step.

Perhaps the acknowledged end of the wage pause will be seen when the government's official statement on long-term wages policy is published. Indications are that it will appear soon.

The Successes of Consultation

Recently, at a "New Thinking Series" luncheon organized by the Industrial Welfare Society, the Minister of Labour, Mr. John Hare, referred to the degree of respect that industry has for the existing wage claim procedures. "Last year," he said, "about 270 official claims for increased wages and shorter hours, covering practically the whole of industry, were settled peacefully. Less than ten resulted in strikes."

Less encouragingly, though, last year we also lost 3 million working days through strikes, the second highest figure since the war. Most of these strikes were in individual establishments, and were in breach of the agreed procedures. This, certainly, is a most unhappy situation, and one very injurious to national productivity, but the most rewarding approach to increasing productivity would surely be to try to analyse why the procedure was abused in these cases instead of introducing a measure which negatives a procedure that was acceptable in 96 per cent of the cases.

The Minister went on to point out that the answer to strikes is not the repressive one of making them illegal. He said, ". . . basically the enforcement of legislation depends on the consent of the majority of those to whom it is to apply. However attractive the various proposals that have been put forward for improving industrial relations by legislation might appear, they all have one serious disadvantage. They wouldn't work. The responsibility for unofficial strikes by no means rests entirely on one side. Moreover, all legislation requires, if necessary, the sanction of prison for those who refuse to conform. You can't send thousands of people to gaol." That seems to put it in a nutshell.

An interesting piece of statistics quoted by the Minister was the fact that 60 per cent of the days lost last year through strikes were lost in four industries only—the motor industry, the docks, shipbuilding and mining—yet these industries together employ only about 7 per cent of the population. Until this year, the top men from both sides of one of these industries—the motor industry—had never discussed their problems together. Bringing them together now might have been the beginning of better relations in the industry, always assuming that the union leaders retain the confidence of their members.

The sting in the tail of the Minister's speech was that at the last meeting of the National Joint Advisory Council, the British Employers' Confederation had agreed to review what they considered to be restrictive practices in their own companies, and for their part the TUC had felt sure the unions would be willing to cooperate in a joint examination of the problems raised. Such a spirit of self criticism on the part of both employers and unions, and a joint effort at eliminating restrictive practices of all kinds is vital to national productivity.

Setting Up Industry where it is Needed

The national unemployment average may seem tolerably low (particularly to those with safe jobs), but the picture is not always so rosy in all parts of the country. Pockets of higher than average unemployment exist in some of the less industrially developed areas and—often more briefly, but usually more catastrophically—in other areas which, though industrialized, depend greatly on a single industry. The classic example of the latter used to be Lancashire cotton; sporadically, it has been Midlands cars; it looks unpleasantly possible that, next, it could be Clydeside, Tyneside and Merseyside shipbuilding.

In the interests of social peace of mind and of industrial productivity (two interests more closely identified than we sometimes stop to think), the national aim must be to use and retrain surplus labour, wherever it might be, in developing new industry. Though Mr. Paul Chambers, chairman of ICI, and like-minded people have been urging that the correct and efficient order of priorities is to move labour to the economically desirable sites, government policies since the war (being more alarmed by the prospect of social reorganization than by that of industrial reorganization) have been to guide and direct firms into siting their new factories where there is spare labour. In the absence of a national plan to encourage the mobility of labour, the latter policy has probably been unavoidable.

Sometimes, however, the two policies can be combined as in the recent announcement by the Rootes group that, alongside the car factory which they are already setting up at Linwood in Scotland, they are going to build a £1½ million high pressure aluminium die-casting plant. In addition to providing employment locally for 500 people, the new plant is economically well sited to serve the growing motor factory and this, in turn, is well sited to use the products of Colville's nearby strip mills. The cynics amongst industrial tycoons can, of course, take the argument back a stage further and ask what, economically, a new strip mill is doing in Renfrewshire, anyway.

The new Rootes Group project has a further significance in that the high pressure die-casting of aluminium alloys is a modern technique of increasing importance to the mass production industries. Indeed, when a motor component manufacturer embarked recently on the large-scale production of a new automatic transmission, one of his main problems was to obtain the required quantity and quality of aluminium alloy die castings. His solution to this problem was to arrange for an American firm to begin production in this country.

Troubled Cathedral City

Another place where the local balance of employment is in the news, though less hopefully, is Gloucester. Late last week the board of the Whitworth Gloster Aircraft Company stated that "after full consideration of the possibilities of future orders and the running down of the existing production programme," it has been decided that the company's Gloucester works will be closed by mid-1962, leaving something like 4,000 people to find new jobs.

This is not the first time in recent years that this sort of bombshell has hit Gloucester. Though there is a frequent misconception that it is merely a quaint amalgam of historic cathedral city and agricultural marketing centre, the city is, in fact, the boom town centre of a busy industrial area. There are traditions of heavy engineering going back into the last century but, since the early days of the last war, local industry has been very much geared to an affluent aircraft industry. This dependence on an industry which is less predictable than most is reflected in local employment and in the local economy.

When, three years ago, the government cut back on production of the Gloster Javelin (and the name, Duncan Sandys, became a term of near-abuse locally in public bar and cocktail bar alike), the Gloster Aircraft Company, as it was then, and its associated companies suddenly faced the necessity for reducing drastically the numbers of their employees, some of whom had settled in the district only a year or two earlier. Just as badly hit were the many small engineering firms in the area engaged in sub-contracting work (one or two of them even had to go to the wall), and the trading houses of Gloucester, Cheltenham and the other towns of the county feared the effect on their businesses. In the streets of Gloucester was the unusual and disturbing sight of thousands of workers marching to mass meetings (and overflow meetings), expressing in their demeanour the odd mixture of embarrassed jollity, indignation and suddenly shaken confidence that is the mark of men who have been living well but have just received the incredible information that things will not long be thus.

By and large, Gloucester rode that storm, mainly through the determined efforts of an industrial development council created by firms and unions, civic bodies and local government officers, trading interests and the local member of parliament. British Nylon Spinners, T. Wall and Sons, and other firms came into the district, and the Gloster Aircraft Company diversified into such fields as agricultural equipment and vending machines. Nevertheless, some individual careers did suffer, perhaps irreparably.

Gloucester, one hopes, will ride this new storm, as she rode the last one, but the energy she must expend in the effort is a reminder that a bland statement of national unemployment figures can sometimes conceal much local anguish.

Management Attitudes and Reactions to Change

Education officers particularly and managers generally have already shown considerable interest in the fifty-page booklet, *Management Initiative* (5*s*), the latest of the Acton Society Trust's publications. This booklet illustrates typical management attitudes and reactions to change and new ideas, and is a crystallization of four of the eight pieces of research in *Case Studies in Management Initiative*, a larger volume which is to be published in the New Year. Two of these case studies, incidentally, were those used by the South London branch of the British Institute of Management at their recent week-end conference on the use of case studies in management training (ENGNG., 6 Oct., p. 436).

For the purposes of the booklet, initiative is defined as "a process of behaviour involving both thought and action, which leads to change in existing patterns." In other words, the book regards initiative as a process in relation to management structure, and not as a single act of intuitive guesswork. It breaks this process down into seven stages, namely, perception of the problem; analysis of the problem; analysis of the solution; agreement to change; acceptance of change; delegation; and implementation. In separating and defining these stages, the booklet provides a framework in which the real nature of management initiative can be analysed.

Though based on original research by a team of social scientists, the book is written in a narrative style and without recourse to technical jargon. If there is an adverse criticism to be made, it is that the book could have been indexed in more detail. However, the important point is that most managements would see their own companies' problems and situations mirrored in the relationships and motivations described. This makes the book very useful as a management training aid and reference work.

The companies in which the research work was carried out were all medium sized companies with between 1,400 and 3,000 employees. Nevertheless, the book should be of interest and relevance to both smaller and larger companies.

Special Article

Engineering Techniques in Modern Art

Artists are today looking to the materials and methods of engineering to further their art.

ARISTOTLE had originally proposed that the distinguishing structure of a thing represented its form, the stuff of which it was made being known as its matter; the two having been indissolubly united from the first. As far as the artistic values are concerned, which may be imposed on this system of things, one can conveniently shift to a theory of aesthetics put forward in recent times by Clive Bell, which also has the confirming virtue of being an extension of the thought of Aristotle's own Athenian master, the immortal Plato.

Clive Bell's theory of Significant Form as applied to the visual arts derived an up to date aesthetic position by explaining the concept from the artist's own point of view of an object as a combination of pure forms, as, to quote Dr. C. E. M. Joad in *Guide to Philosophy*, his possession of " the capacity to discern the element of reality which is latent in the object, to disentangle it from the sensuous material in which it is embodied, and, by expressing his vision of it in his picture, to enable us to glimpse the pure form he has visualized."

Thus far metaphysics, as a background to man's developed regard for the matter of his world as a medium for expressing his most esoteric understanding in life. Confronted with the imperative need to symbolize these feelings materially, artists across recorded time have of necessity had to resort to materials around them to make a new form stand for a new experience. The earth pigments of the paleolithic cave paintings of Lascaux and Altamira have lasted till today as they would have lasted if unused: the stones of the Parthenon have been eroded with the centuries. Bronze vessels from Chou dynasty China (12th to 3rd Century BC) come to us with little attrition. The gold and obsidian figures of ancient Egypt survive unscathed, the pottery of Rome and the wood ships of the Vikings have suffered the depredations inflicted by time.

These are some of the immemorial art materials: but visual aesthetics at the turn of the last century, with the Impressionist *éclat* following upon Turner's unusual vision, presaged the coming of new art demands on available material; and this trend was in synchronism with a gradual arousal of the creative mind to the incidence of the new technologies on the world.

DREAMS AND REALITIES

It was not long before the inspired and fantastic " mechanical " drawings of Paul Klee and the appliqué effect of pieces of paper and cloth stuck on to canvas in the *collages* of Cubism and Dada were joined by the sculpture of Constructivism, where abstract figures were made from wire, glass and sheet metal. This last movement, as practised by Naum Gabo and Antoine Pevsner really set the scene for a general turning towards the technical world and to engineering for the means if not the ends of art. In *The Meaning of Art* Sir Herbert Read explains that the geometrical forms produced by Constructivism were aimed at creating " a dynamic interrelation of solid masses, planes, and space which will be in perfect tension. Whether such forms are ' beautiful ' in the usual sense is perhaps arguable, but if we read what a humanistic sculptor like Rodin has to say about his art we find him using exactly the same terms—planes, volumes, tension, equilibrium."

The curvilinear cubism of Fernand Léger's drawings containing dynamic shapes of machinery, with cones, cylinders, cogged wheels, pistons and brilliant metal surfaces, asseverated this as subject matter interest, as the framework sculptures of today seem to affirm the materials themselves, with such *objets trouvés* as nuts, bolts, ratchets and other " plagiarized " impedimenta of engineering welded onto open work metal structures—examples here being with the work of Peter Clough.

METAMORPHOSES

It should be borne in mind, though, that the " idea " and the " material " are not separate: the feeling for the subject in the material and the optimum overflow of inspiration into the stuff of expression itself means that the artist conceives of these two worlds as one reality—symbolized in the fusion of his art. There can be, and is, for example, an art of engineering, the products of which are art forms in so far as they are likewise as comprehensive in realization. Art should not be a special field, and is not except by misleading convention; the wise words of Dr. A. K. Coomaraswamy are apposite: " The artist is not a special kind of man, but every man is a special kind of artist."

For the painter, rising past the plaster wall-painting frescos of Giotto and Cimabue in the 13th century, past the supreme graphic mastery of Dürer's woodcuts and the painted wood, canvas came to be accepted universally as an excellent backing material, with its keying properties and resilience. Nowadays, fibre boards can provide the artist with a working background. The plaster gesso and opaque water gouache have their modern counterparts in sand as a paint base and in the use of thixotropic paints. The discovery of the aniline series of dyes by Sir William Henry Perkin in 1856 brings to mind Tintoretto's resourcefulness in the 16th century in grinding his own colours.

In the field of plastics, Perspex has been widely used by Arthur J. Fleischmann in a remarkable range of sculptures, including " Lot's Wife," in which the pillar of salt similitudes can be appreciated. Bakelite polyester resin has been used with telling effect in a 300 sq. ft mural in the club room of the Brooklands Park LCC Housing Estate—a method of decoration evolved by Mr. W. G. Mitchell, Des.R.C.A., A.I.B.D.

Aluminium, the substance of Eros in London's Piccadilly Circus, has been employed very recently for a vast relief by Geoffrey Clarke in Castrol House, London, depicting the use of oil in modern society.

A new technique for producing sculpture from the original has been developed by Jana Moravcová-Modlová, Luboš Moravec and Miroslav Formánek, by applying a layer of metal to the matrix original by plating or spraying, the shell being then stiffened with plastics. After hardening, the metal surface is cleaned and welded and appropriately finished—the process being fast and economical. Mr. Peter Watts, a Bath sculptor, has used an Atlas Copco air compressor and chipping hammer for the rough work on his restoration of Bath Abbey figures, for necessary speed and less fatigue.

FUNCTION AND FORM

Glass staining for cathedral windows has also benefited in this era from researches into the penetration of pigments, and glass itself has entered into sculpture and architecture in novel ways. Victor Pasmore works in Formica structures and enamels today, and Michael Ayrton with wax modelling on glass frameworks. Such modern movements as *Tachisme*—embracing " Action Painting," with its semblance of inspired abandon—give limitless scope for the application of devices and materials in producing a design.

Mr. Leslie Thornton has developed his own technique for bronze-welded sculpture, using British Oxygen Company equipment, and describes his work as " an exploration of form and tension, suggesting pent-up energy." His figures are formed basically from welded deoxidized copper strip reinforced with Brazotectic welding rods: various quenches produce a variety of colours.

Mr. R. Bentley Claughton, D.A.(Lond.), A.R.B.S., is an authority on the use of technical materials in art, having been a professional engineer before becoming a practising artist and sculptor (" The Shape of Things," by R. Bentley Claughton, ENGNG., vol. 182, 1956, p. 483). Today he tells ENGINEERING of the need which sculptors feel at present for more cooperation from the manufacturers of many of the new materials now being exploited in art—frequently it is difficult to obtain bulk supplies which are sometimes packed in small quantities for ordinary use. Good results are being obtained with the working of resin-impregnated glass fibre for sculpture, and with a form of Celotex using latex and water to set-off the interior fondu—the resultant material being plastic and resistant. Dental materials in the form of ivory-like plastics are also being employed, and there is a need to develop the supply of new low-melting point alloys which will not be too soft for working. Ciment fondu is now being widely used, and Mr. Claughton reports that the students of the Slade School are treating it as an aggregate in conjunction with glass fibre mat to make strong thin structures. He emphasizes the urgency for research between artists and suppliers to determine what is needed and how it can be supplied. Sculptors today are looking to the engineering and building fields for their materials, where structures are thought of as large.

OLD CAR BIZARRERIES

Another case of *objets trouvés* recently has been with the use of compacted old car bodies as components of sculptural design: this movement started in Paris, and then took root in America. In London much bronze casting is now being done of sculpture involving the pressing of cogs and spurs onto bronze in works aiming to capture the mood of engineering.

The artist therefore not only keeps abreast of material developments, but can throw up monuments to the general and technical progress of man. These in turn may inform technology of the impression it makes on history, and of the ways in which it might serve better by taking itself, if not more seriously, at least more responsibly in the widest sense, as a fellow member of the interacting arts of man.

Welded deoxidized copper strip reinforced with Brazotectic welding rods goes to make up the sculpture of Mr. Leslie Thornton.

Building Economy with High Tensile Steel

British steelmakers have developed a weldable structural steel with a yield point of 22 tons per sq. in. The price will make it more economical than existing steel under most common loading conditions.

BRITISH structural engineers are now able to obtain a new high yield point steel of good welding quality. Its adoption in general structural work promises considerable economies with respect to mild steel or the high tensile steels that have been available so far.

The British steelmakers have produced their specification for the new steel and this has been submitted to the British Standards Institution; there is a general expectation that the specification will be adopted as a standard, at least in respect of its salient features, probably early in the New Year. The specification is intended to replace the existing BS 968:1941 for rolled section (and the corresponding BS 548 for plates). BS 968 was introduced under wartime conditions to cover what, at that time, was thought to be a high yield point steel suitable for fusion welding.

Experience has shown that the maximum alloy content allowed by BS 968, necessary to attain the specified mechanical properties, is too high for satisfactory welding, especially in the thicker sections and plate. Moreover, the mechanical properties of steel to BS 968, particularly the yield point, decrease rapidly as the thickness of the material increases, the yield point falling from 23 tons per sq. in (51,520 lb per sq. in) for thin material to 19 tons per sq. in for plates over 1 in or sections over ¾ in thick.

UTS OF 32 TONS PER SQ. IN

Recent improvements in steelmaking have now made it possible to supply a steel with guaranteed yield point exceeding 22 tons per sq. in (49,280 lb per sq. in) for all thicknesses up to 2 in (which nearly covers all the universal sections) with a smaller alloy content and with carbon contents somewhat lower than for the earlier BS 968 steel. Because of these changes, the weldability of the new steel is markedly better than that of the earlier steel, though reasonable precautions will still have to be observed during fabrication. The ultimate tensile strength will have a minimum value of 32 tons per sq. in.

The steelmakers claim that the higher yield points provided by their new steel will allow more economical design of steel structures, particularly when based on BS 449:1959. When it is added that the price will be lower than for BS 968 steel, it is certain that there will be a cost reduction for steel structures that might have been designed in existing high tensile steel. Further analysis, reported below, shows that, subject to qualifications, most frameworks of the new steel will also be cheaper than they would be in the conventional mild steel to BS 15.

In Britain there has probably not been a building frame erected in high tensile steel. The bridge people have made good use of the higher quality steel, but they are in a better position to be able to effect economies by the adoption of higher stresses, with consequent smaller sections and therefore a smaller dead-load, than are the building-frame designers. Then again, the bridge engineer is usually better informed about the timing of his requirements than the man concerned with a building frame. The latter, after having produced the basic design, often has only the shortest of periods after the go-ahead is given to obtain his steel: he necessarily has to take what he can get and, with the further inducement of the lower price of mild steel as compared with existing HT steel, the frame has been erected in mild steel.

On the Continent, circumstances have been rather different and there are a number of examples of frame buildings of HT steel. In North America, where the structural steel industry has still got the measure of the concrete industry, the situation is quite different and there are good examples of multi-storey buildings using high strength steels.

AMERICAN EXPERIENCE

The advantages which the Americans have found with these steels are given briefly, but adequately in an article entitled "How to Use High-Strength Steels" in the first issue of the American Institute of Steel Construction's new *Modern Steel Construction*, their successor to *Steel Construction Digest*. In the article it is pointed out that the economy obtained by employing HT steels for columns in office buildings varies almost directly with the increase in the strength of the steel if the *l*/*r* ratio is less than 60, but as the *l*/*r* ratio increases, the strength/weight/cost economies decrease.

Dead and live loads both accumulate in the columns of a building, so that the maximum loads occur in the lower storey columns, with a gradual reduction in load towards the upper levels. It is therefore very practical to use high strength steel for the columns at lower levels but cheaper mild steel for those in the upper storeys.

The advantages of using high strength steel are shown to be a reduction in the total amount of steel; less costs in fabrication by utilizing same-size columns of different strengths, and the elimination of cover-plated columns; lower transport costs due to the reduced weight of material used; increased usable floor space, and therefore a higher return on the investment; reduced cost of fire-proofing because the column sizes are smaller; and, finally, simplification of architectural details throughout the building.

In the case of a 16-storey building for the Standard Insurance Company in Portland, Oregon, the designers reduced the steel tonnage by 20 per cent (560 tons) by using a high strength steel (A 440) instead of the most commonly used carbon steel (A 7). The greatest saving was in the columns, where a reduction of 23 per cent was obtained. Use of A 440 in the beams gave a reduction of 19 per cent in the weight of these members. In designing this building, the basic stress allowed was 30,000 lb per sq. in, which is 50 per cent higher than the 20,000 lb per sq. in permitted with the mild steel A 7. The primary benefit is succinctly stated to be an $80,000 saving in cost on the completed building.

Canada too has seen some recent developments in high strength steels, in particular that covered by the Canadian Standards Association's steel specification G40.8. Though intended primarily for bridges, it is also expected to be generally used for buildings and other structures, replacing the more commonly used structural steels: its high yield point—40,000 lb per sq. in for thicknesses up to ⅝ in—its resistance against brittle fracture and good weldability—the equivalent carbon content is 0·30 for grade A—all help to make it a versatile and economic steel for structural purposes.

One of the first major jobs on which G40.8 will be used will be the six-lane bridge over the Welland Canal at Homer. The length of the bridge between abutments will be 1¼ miles and this section will be of plate girders throughout; the approach spans will be composite plate girder design. In the west approach and the main spans G40.8 will be restricted to the welded plate girder cross beams but in the eastern approach, where there are to be thirteen 150 ft simple span girders of composite construction, 4,800 tons of the new steel will be used; the principal members in the section will be all-welded plate girders 9 ft 3 in deep.

The economics of using universal beams rolled in the new British steel for building frames have been discussed by Mr. Charles Gray, the technical adviser to the British Constructional Steelwork Association, in the association's quarterly *Building with Steel* for November (Vol. 1, No. 8, 1961). This article is limited to a consideration of universal beams but a subsequent article, in next February's issue, will discuss the potential economies when the steel is substituted for the existing steels in columns.

Mr. Gray points out that, on the basis of previous British Standards, it is reasonable to expect that the permitted working stress in beams of the new steel will be between 14·5 and 15 tons per sq. in, and his own arguments he bases on the lower of these two figures (32,480 lb per sq. in). Economics of the new steel are dependent not only on higher working stresses, and therefore lighter scantlings that are required to carry any given live load, but also on the cost; there is also the accumulated advantage in a large structure of the reduced dead load.

The price reduction on the earlier high tensile steels is remarkable. The quality extras per ton for joists and column sections are respectively 2*s* 6*d* for mild steels to BS 15, £7 10*s* for the high strength steels to BS 968 and 548, but only £4 12*s* 6*d* for the new steel. With its improved weldability and higher yield point plus the reduced price it is certain that it will supersede the existing high strength steels for all purposes and also, in many cases, ordinary mild steel.

To determine the structural conditions under which the new steel would be more economical than mild steel, Mr. Gray took the cost of mild steel beams in a multi-storey building to be £75 per ton in place; that is, fabricated, delivered and erected. The extra cost of the new steel is therefore £4 10*s* per ton, or 6 per cent on the steel in place. Basing his arguments on the most common condition of a uniformly distributed load, Mr. Gray found that, for a span-depth ratio not exceeding 13½, an economy of 32 per cent in cost and 38 per cent in material weight can be obtained if the new steel is substituted for mild steel, falling to a 6 per cent saving in material and equality in cost for a span-depth ratio of 17.

OPTIMUM GRID DIMENSIONS

The new steel therefore calls for a re-assessment of the planning grid commonly in use for multi-storey buildings with mild steel frames since, to effect the full economy of the new steel, the beams must be stressed to the permitted maximum. To avoid the deflection criterion, spans will require to be shorter than hitherto. Mr. Gray points out, however, that BS 449 permits the maximum deflection to exceed 1/325th of the span if such a deflection will not impair the structure or damage the finishes. He concludes his article on beams by suggesting that, as the lightweight casings are now fixed after the full dead load has been developed, and subsequent deflection is due only to superimposed live load, the time may have come to consider alleviating the deflection criterion; this would have the effect of extending the economic advantages of the new steel stated previously.

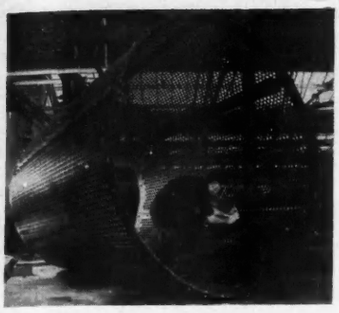
Similar sorts of arguments applied to columns lead to the conclusion that, even allowing for the extra charge, the new steel will show an economic advantage of 25 per cent on the smaller sections rising to about 33 per cent on the heavier sections as compared to mild steel.

The really interesting point still remains to be resolved. It is generally reckoned that, in Britain, a building with a concrete frame can be completed for about 12 per cent less than that with a steel frame. Will the 30 per cent or so reduction in steel costs be sufficient to bring the cost of the finished building down to a competitive figure?

Screens for Grading Gravel

During last year 76 million tons of sand and gravel were extracted in the United Kingdom and a large proportion of this was graded and washed before sale. Use of the perforated rotary drum screen is a popular method of grading where the hole size in the screen governs the size of gravel passed through.

The plate used in the screen may be up to ½ in thick, and the sheet steel is perforated with the required holes before shaping into either conical



Conical rotary gravel screen.

or cylindrical drums. The perforations may be round or square holes or round-end slots. The screen plates are then rolled to the correct shape and bolted or welded together to form the complete drum. A reinforcing band is bolted or welded round the rim at the discharge end, and a steel angle ring is fitted at the intake where the drum is connected to the rotating machinery.

Depending on the material used gradual erosion will eventually increase the hole size, making replacement necessary.

The illustration shows an 8 ft long tapering screen made from ⅜ in thick steel plates in six separate sections. The angle ring at the intake has still to be fitted.

G. A. Harvey & Company (London) Limited, Greenwich.

Pedestrian Subway Under the Strand

The Roads Committee of the London County Council have approved a pedestrian subway from the junction of Duncannon Street and Adelaide Street and the Strand Underground Station. There will be entrances from Charing Cross station forecourt, the north and south sides of the Strand, Duncannon Street and Adelaide Street. At a later date a connecting subway leading to the north side of the Strand east of Duncannon Street may be added.

In spite of the physical limitations set by the Charing Cross Underground Station, it has been possible to design a subway 16 ft wide within the Underground Station entrance, and 18 ft wide under the Strand. Access will be by stairways.

The scheme will cost about £315,000 and work is planned to begin towards the end of next year. The LCC say that it will be necessary to make a partial closure to the Strand while work is in progress, but it would always be possible to lay a bridge deck over the line of the subway and excavate below that.

70 ft Deep Under-Reamed Piles

The new head office of the Brown and Pank brewery concern at Stockwell will be founded on 80 large-diameter under-reamed deep bored piles, which will have a maximum depth of 70 ft. The maximum diameter of the piles is 5 ft.

The £618,000 project, which is expected to be completed by the summer of 1963, is the first part of the redevelopment of the former Stockwell brewery and will have five storeys. The second part of the scheme is planned to follow in five years, including bottling lines and storage capacity.

The reinforced concrete floors have been designed in flat slab construction and the column grid is 27½ ft by 22 ft. The lower floor storeys will be of reinforced concrete and the top floor, which will contain the administrative offices and canteen, will have a structural steel frame.

The building will be generally clad in facing brick and will be 300 ft long, 100 ft wide and 63 ft high. In addition to the lift tower and tank room rising from the roof there will be four open courtyards.

The architects are Tripe and Wakeham, 16 Fitzhardinge Street, London W1, and the main contractors Holland & Hannen and Cubitts (Great Britain) Limited, 1 Queen Anne's Gate, London SW1.

Suppressing Transformer Noise

A circular brick enclosure for transformers has been found to eliminate almost entirely the noise nuisance. Standard practice has been a rectangular enclosure which, though adequate at ground level, has always allowed the noise to spread out from the top so that it reached adjacent buildings that were even slightly higher than the enclosure. The circular enclosure apparently possesses the ability to "funnel" the noise vertically upwards so that even nearby buildings are not subject to the annoyance. Moreover, the

The TW circular enclosure for eliminating transformer noise nuisance. The hum does not reach the windows.

circular enclosure can be built for half the cost of the traditional rectangular type because it can be built of a single thickness of bricks against the two thicknesses or buttresses required hitherto.

This simple solution to transformer noise suppression has been conceived by Transformers (Watford) Limited. Simple experiment shows that it works. Noise suppression, especially at adjacent heights just above the level of the top of the enclosure, is markedly better with the circular than with the rectangular enclosure. The saving in cost comes because curved bricks of the type used for chimneys and silos can be used and for all required diameters and heights —18 in to 3 ft above the top of the transformer— only one thickness of brick is necessary. This means that the number of bricks needed is roughly half and the bricklayers' time is also halved compared with building the familiar rectangular pen.

An incidental advantage of the circular form is that the minimum clearances occur at the corners of the transformer (where it is only necessary to provide passage way) but there is more space at the sides and ends where maintenance has to be done.

The bricks required can be obtained as standards from the London Brick Company, who are the parent company of Transformers (Watford). They are made radiused in a number of sizes appropriate to ranges of diameters of the structure, and are available in a variety of colourings that can be chosen to match their surroundings.

It remains to be determined whether the circular form possesses fundamental characteristics that can be applied more widely in the suppression of noise.

Transformers (Watford) Limited, Sandown Road, Watford, Hertfordshire.

Roof Top Lake Cools Building

To reduce the load on the air conditioning plant for the industrial buildings of Cadbury-Fry-Pascall, in Welland, South Australia, the roof has been constructed to carry a lake of water up to 6 in deep. The water also provides insulation, ensuring even temperature of the personnel working in the buildings.

For the construction of the roof, bitumen-impregnated cane fibre has been used to a depth of 3 in, and additional care had to be taken against leakage, involving extensive use of mastics and waterstops.

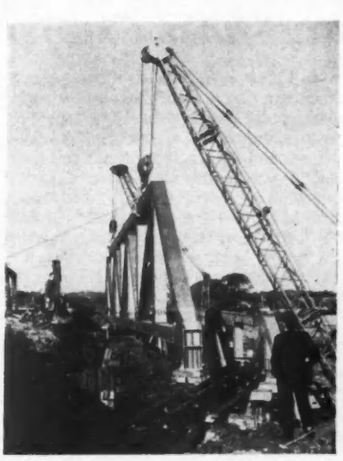
Another feature is a water stop, which has a central bulb providing for both shear movement and the normal thermal movement of the structure.

Truss Bridge Erected During Weekend

For what is said to be the first time in this country, a single-span pre-assembled steel railway bridge of the truss type shown in the illustration has been erected during the weekend. The bridge, weighing over 90 tons, has been built at Wheatley on the Princes Risborough-Oxford line, and it will cross part of the A40 dual carriageway.

Work began on the erection early on a Saturday last month when cranes lifted the steel sections on to two steel trestles forming a runway. Hand-operated winches were used to manoeuvre the structure into position on the abutments. The line was reopened the following Monday morning.

The units were built by Fairfields Limited, Chepstow, and transported to the site in sections,



Bridge girder being lowered on to runway.

where they were reassembled on the ground adjacent to the line, about 16 ft below the level of the existing span.

An additional abutment which has foundations piled to a depth of 40 ft had been built to carry the western end of the new span and an existing abutment is being reconstructed to form a central pier between the dual carriageays to carry the two spans.

Work Begins at the Roseires Dam on the Blue Nile

Main work on the Roseires Dam on the Blue Nile is being formally inaugurated on Saturday, 26 November—one of the most ambitious projects which British consulting engineers have advised upon in the Sudan.

In 1952, Sir Alexander Gibb and Partners of London undertook to investigate the possibility of a storage dam on the river and recommended the siting and type of construction of the dam. Later the French firm of André Coyne and Jean Bellier were engaged as co-consultants on the project, which is under the direction of Sudan's Ministry of Irrigation and Hydro-Electric Power.

Ultimately the dam will make it possible to store 6,000,000 acre-feet of water (sufficient to cover the whole County of London to a depth of 80 ft). The first stage is expected to be completed in the summer of 1967, when the dam will stand 200 ft above the foundations at the deepest part of the river-bed. At this height it will impound 2,400,000 acre-feet of water. The design allows for a second stage, when the crest will be raised a further 32 ft for the full storage capacity of 6,000,000 acre-feet.

The dam itself will be a concrete buttress construction about 3,610 ft long, flanked on either side by earth embankments about 7 miles long on the west bank and 2½ miles on the east. The concrete section will incorporate five sluice gates distributed over the width of the dry-season bed of the river. The gates will be of a radial type, each 33 ft high by 20 ft wide, and will be used to control the flow of water through the dam; they will be placed low to reduce the accumulation of silt in the reservoir.

To the west of the sluice section there will be a surface spillway controlled by seven radial gates, each 39 ft high by 33 ft wide, to augment the deep sluices during the peak of the annual flood. The combined discharge capacity of all the gates will be about 613,000 cusecs. This compares with the highest estimated discharge of 381,000 cusecs at Roseires since records were first taken in 1912.

There will be a small service 2,000 kW power station in the dam to work the gates and other machinery. Provision has been made for a future hydroelectric scheme equipped with seven 25 MW turbo-generators, one of which is to be a stand-by set. The buttresses in this section have been designed to allow the power station to be built later without interfering with the operation of the dam.

Some 1,100,000 cu. yd of concrete will be used in the dam's structure, together with 4,500 tons of steel reinforcement. The foundations will involve 2,800,000 cu. yd of excavation, and 5,300,000 cu. yd of earth will be needed for the embankments.

The Italian firm of Impresit-Girola-Lodigiani, who were the lowest tenderers, secured the civil engineering contract for a total sum of nearly £20,200,000.

When the first stage of the dam has been completed, water will be provided for the Managil irrigation scheme on a permanent basis without restriction. It will be possible to change and diversify the crop-rotation in the Gezira and Managil areas, providing an additional cotton crop of some 300,000 acres, and to irrigate a further 200,000 acres by gravity on the fringes of the two schemes. These and other benefits will provide a living for some 60,000 new tenant families.

Underpass Built into Existing Tunnel

The Roads Committee of the London County Council is considering making alterations to the disused Kingsway tram tunnel for traffic between Waterloo Bridge and Kingsway. It is proposed to use the original tunnel between Lancaster Place and Kingsway, opposite Portugal Street, where ramps will be provided to the surface. The tunnel will be 12 ft 6 in high and provide a 17 ft wide carriageway, with a verge on either side of 1 ft 6 in. It will normally be used for north-bound traffic only but provision can be made for two-way traffic.

The consulting engineers, Frederick S. Snow and Partners, initially suggested that a louvred canopy should be placed over the southern approach ramp, as a safety factor to grade the contrast between daylight and artificial light and to prevent the sun shining down the tunnel. This, however, has been abandoned since the normal direction of travel will be from south to north (away from the sun). But the money saved will be spent on providing an improved system of light graduation by artificial light.

The side walls of the approach ramps will have a dark non-reflective surface, and the tunnel itself will have a false wall and ceiling of aluminium, which will be treated to avoid confusing reflections; it will also be lined to reduce the noise. The road surface will be hot-rolled asphalt, giving a dark appearance to contrast with the walls and ceilings. Lighting will be on two continuous rows of shielded fluorescent tubes in the angles between the walls and the ceiling; and the lighting at the south end will be graded to reduce the contrast between artificial and natural light to a minimum.

Limitations imposed by the width and height of the tunnel and the gradient to the approaches will make it necessary to restrict the size of vehicles, and it may be necessary to include some form of automatic light ray detection to warn vehicles that exceed the height limit.

Work should start on the tunnel in April next year. Although part of the tunnel is used by the British Transport Commission for storage, the LCC has a compulsory purchase order on the property if it is needed. The expected cost of the modifications is £797,000, which is £197,800 more than the original estimate. During the preparations of the detail design it was found that the structural work would cost more, and there is also included in the revised figure an anticipated £60,000 increase for rises in labour costs and materials.

Canadian Exposure Tests on Building Materials

Seven outdoor test sites for the exposure of building materials have been established by the Division of Building Research of the National Research Council of Canada. Two sites are located at Halifax and one each at Montreal, Ottawa, Saskatoon, Norman Wells, and Rocky Point on Vancouver Island. At these sites weathering studies are undertaken to determine the effect of the different atmospheric conditions on the performance of selected materials.

Site locations were chosen in the first instance to provide a marine atmosphere, a marine-industrial, industrial, a rural location with high humidity, one with a low humidity and a far northern site. Through the cooperation of the American Society for Testing and Materials the reciprocal use of their sites has been arranged and thus an even broader range of exposure conditions are available when needed. The facilities provided for exposure testing and a more detailed description of the sites and their operation are given in publication 5593 of the National Research Council.

Many different building materials have been exposed at the test sites since the beginning of the study in 1954. The programme has included three steel alloys—a plain, low carbon, a copper bearing and a copper-nickel bearing steel; three stainless steel alloys, two magnesium alloys, a rolled zinc, three aluminium alloys and riveted galvanic couples of aluminium 3S alloy to mild steel, to zinc and to copper. These metals have now been exposed for seven of the ten years of exposure planned for them. Recently specimens of sheet copper, Mantz metal, two types of sheet lead and monel metal have been set out. A summary of the atmospheric corrosion resistance of those metals having completed one, two and five-year periods of exposure has been published in report NRC 6260.

Comparison of the performance of different metal coatings on steel has also been started. The coatings that have been set out at the sites to date have included hot-dipped galvanizing, electroplated zinc, sprayed zinc, sprayed aluminium, aluminized steel, and electroplated cadmium. Twelve specimens are prepared for each site of each type of metal coating or sheet metal selected for exposure. Three specimens of the sheet metal materials are removed at intervals of one, two, five and ten years of exposure. Specimens of metal-coated materials, however, are removed from the sites only as failure appears.

Two series of different paint systems applied to steel have been exposed at the sites. Series I consisted of five priming paints, a wash primer and one enamel for top coating. Different systems were applied by dipping to cold-rolled SAE 1010 Steel. In Series II, four CGSB steel priming paints plus a zinc dust primer and a zinc rich paint have been applied to structural steel for exposure. An alkyd enamel was used for top coating. These paint systems were applied to the structural steel plate in the following conditions: mill scale intact; weathered and wire brushed; grit blasted; and grit blasted and flash rusted. The last panels completing this series were set out in 1960.

Because of the size of the test piers that are usually required for weathering different brick and mortar combinations it has been necessary to restrict exposure of these materials to the Ottawa and Halifax sites. Correspondingly, because the weathering of bituminous coatings requires removal of the panels after short exposure periods for laboratory examination, these materials have only been exposed at Saskatoon and Halifax (where regional stations of DBR are located) and at Ottawa.

Some sites affect the performance of the materials far more than others. The results of exposure of the metal materials have shown the Halifax industrial-marine site to be the most corrosive of all the sites. The loss of metal from specimens exposed at the Montreal industrial site was much less. The Halifax marine site, Ottawa, Saskatoon, Rocky Point and Norman Wells follow in that order. This order of severity in general applies to weathering of other materials and any differences in degradation that have occurred at some of the less severe sites have been attributed to a local condition.

Publications mentioned above can be obtained from the Publications Section, Division of Building Research, National Research Council, Ottawa Canada.

Facing Up to the Facts of Fall-Out

Russian nuclear tests have provoked fresh consideration of the effects of fall-out. What damage may occur from the radioactivity released by nuclear explosions?

DURING the past few weeks many views have been expressed on the effect that might reasonably be expected from the radioactivity released to the atmosphere by the recent series of Russian nuclear tests. The alarmists imply that succeeding generations will all be affected in some way by the genetic mutations caused by the latest release, and others who are complacent say no harm will come. From the diversity of opinion, it may be surmised that there is still a great deal to be learnt about the effects of radiation to the population.

It would appear that the western part of the northern hemisphere has escaped the large anticipated fall-out from the 30 and 50 megaton explosions—in spite of the gloomy speculation beforehand, although reports from China show that there has been an excessive increase in the northern region of that country.

The large proportion of radioactivity release in an explosion comes from the initial fission reaction used in the atomic bomb to set off the fusion reaction—the two cycles forming the so-called hydrogen bomb, since the hydrogen nucleus is used. The fission reaction is the same as that taking place in a nuclear reactor but by combining two masses that already are close to the critical weight, the resultant uncontrolled explosion releases a high proportion of fission products. In a reactor these fission products will not only be fewer in number but by using suitable materials in the primary circuit they are all contained.

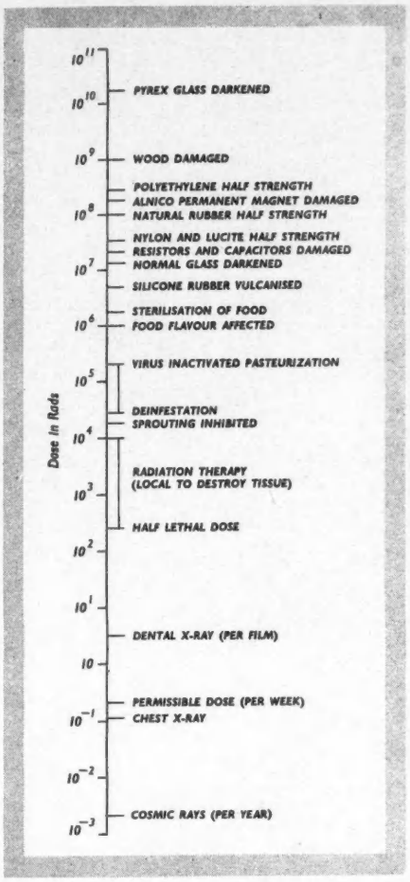
The heat released by the fission explosion sets off the fusion reaction, where only a little radioactivity will be released.

FALL-OUT FACTORS

The distribution of the radioactive fission products therefore depends on the size of the explosion, and also on the position in the atmosphere of the actual burst. When the explosion takes place near the earth's surface most of the larger fission products are deposited in an area downwind from the site of the explosion. The remainder of smaller products will come down slower and further away from the site, usually assisted by rain. If the explosion is large and in the megaton range some of the debris will be thrown up into the stratosphere or upper atmosphere above the tropopause. In this region there is no rainfall to accelerate the downward movement of the particles and the rate of vertical movement is very much slower. The particles may remain in this area for years before entering the lower atmosphere or troposphere, and the particles will have a world-wide distribution.

It has been found that there are two main ways in which stratospheric particles reach the earth and both are dependent on the particle's density. The first is by a sinking of air in the polar regions, particularly; in the second by vertical diffusion or horizontal transport in equatorial latitudes. The remaining area is protected by the tropopause—the layer between the stratosphere and troposphere. The longer the particles are retained in the upper atmosphere the better, since the radioactivity decays according to an inverse exponential law. An important parameter in measuring the decay of an isotope is the half-life; this is the time taken for a radioactive isotope to decay to half its original value.

The units of measurement for radioactivity are rather confusing due to their number. The *curie*, named after the discoverer of radium, is based on the estimated reactivity of a gram of radium, and is defined as the quantity of a radio-



The radiation doses when damage is caused to various materials.

active species decaying at a rate of 3·7 disintegrations per second. The amount of radiation actually absorbed by some media is measured in *rads*, and one rad corresponds to 100 ergs of energy per gram of tissue. This quantity is also approximately equal to one *roentgen*, used for the unit of X-ray dosage. A further unit is introduced since the biological effects of radiation depend not only on the amount of energy absorbed but also the type of radiation, and the *rem* (Roentgen Equivalent for Man) reflects the biological efficiency of the energy absorbed in relation to an equivalent amount of X-rays of 250 kV energy. However, for beta, gamma and X-radiation the relative biological efficiency is normally unity and the dose in rems is equal to that in rads.

DANGEROUS INGREDIENTS

There are four main radioisotopes released from a nuclear explosion: strontium 90, caesium 137, iodine 131 and carbon 14. Strontium 90 has a long half-life of 27 years and is readily absorbed from the intestinal tract and concentrates in the bone, where it will have most effect on growing children. Strontium 90 may be taken up by the roots of plants, and later absorbed by parts of the plant above ground. It has been estimated that 95 per cent of the strontium 90 that a person ingests comes from foodstuffs, and the remaining 5 per cent from drinking water.

Caesium 137 has a half-life of 30 years and in much of the deposited material its activity has been found to be 1·7 times that of strontium 90. Caesium is held in the soil in forms that are largely inaccessible to plants. It is freely absorbed from the human intestinal tract and appears to remain in the body for a limited time.

Iodine 131 has a half-life of 8 days, and concentrates in the thyroid gland. Due to the short half-life it has been found unlikely that the dose received from weapon testing will have exceeded one-quarter of the radiation received from natural causes. However, iodine 131 and strontium 90 may contribute significant genetic changes to future generations.

Carbon 14 has a half-life of 5,600 years and produced from natural causes delivers a dose of about 1 mrad per year.

Up to the commencement of the recent Russian series of tests, it has been estimated that the maximum dose incurred in any generation of 30 years as a result of nuclear explosions is likely to be some 1 per cent of the natural background, which is about 100 millirads per year.

Cosmic radiation gives on an average about 24 mrads per year in the United Kingdom, although this dose will be higher in the mountainous areas. However no marked difference has been found between the people who live in these areas. It is estimated that one hour spent at 50,000 ft is equivalent to half the annual natural background dose. Cosmic radiation also produces neutrons in the upper atmosphere which interact with nitrogen nuclei to give the radioactive isotope carbon 14, and beryllium 7.

NATURAL CAUSES

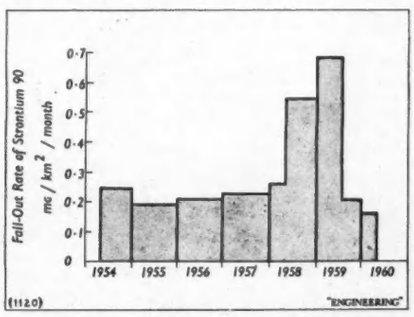
Naturally occurring radioactive elements such as uranium and thorium are found in trace quantities in rocks and soils, especially in areas of granitic rock. In these areas the inhabitants are inevitably exposed to alpha, beta and gamma rays. As part of the radioactive decay, chain radon and thoron gases are produced; the latter gives rise to polonium via radium D.

Radioactive isotopes of potassium, radon, thoron and plutonium all contribute to the natural background dose—potassium 40 being one of the major contributors.

The type of diet can greatly affect the intake of radioactivity: the Western low carbohydrate diet has a total alpha activity of 5 microcuries per day, but the higher carbohydrate diets may reach a value of 100 per day. In the case of certain nuts, especially Brazil nuts, the value may reach 10 times this amount.

In addition to sufficiently large doses of radiation causing gene mutation and chromosome breakages or alteration in the chromosome number, it has been found to give rise to leukemia. A marked increase has also been found in cancer but it is too early to say if this has reached a peak. Early radiology has also revealed an increase in cancer of the skin and certain abdominal organs. However, the protective measures introduced have greatly reduced the number of cases.

Though radioactivity from nuclear explosions is small compared to the natural background, the danger of more explosions is real.



Average rates of fall-out of strontium 90 in the United Kingdom in periods between 1954-1960.

BUILDING EXHIBITION

Olympia, London, 15-29 November

The 1961 Building Exhibition has as its underlying theme the subject of technical information. This bi-annual display constitutes a shop window where the latest practices and achievements of the many allied industries concerned may be examined. It is always a focal point for technical know-how, which on this occasion is being given particular prominence.

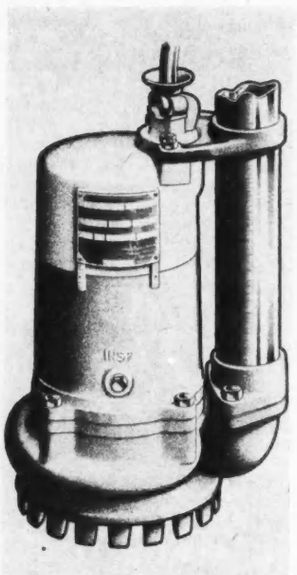
All branches of the industry are represented and much of the plant and equipment is shown in operation. In this connection the erstwhile dustbin upon which demonstrators of woodworking machinery relied for waste disposal, has been replaced by a suction plant, servicing 16 stands, supplied by Dallow Lambert Limited of Leicester.

Having regard to the increasingly important role of technical literature in industry, the model library and display illustrating the requirements of trade technical literature is of special interest. The comprehensiveness of the exhibition may be gathered from the sections into which it is divided; these are materials, heating, woodworking, contractors plant and machinery, painting and decorating, general building products, and international exhibits. In addition there is a service centre. The National Joint Council for the Building Industry is daily staging apprentices competitions.

Many of the exhibits, including those which are illustrated and described on this and the following page, are new developments.

SUMP PUMP

Suitable for Indoor or Outside Use



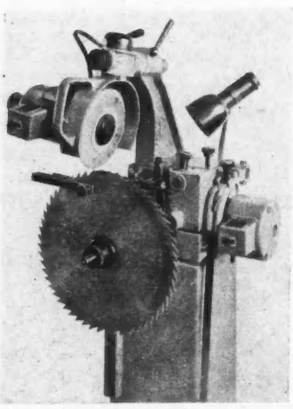
THE Flygt GP sump pump is intended to handle sub-surface water, rain, or spillage, at levels lower than the normal drainage system.

It is claimed that the submersible pump, set in a sump is unobstructive and unobtrusive, while remaining easily accessible. This unit is said to be a simple and practical solution to deep drainage problems, suited to use in or out of doors, and applicable to many situations, including excavations and underpasses. The unit is stated to be able to handle moderate amounts of suspended or dissolved matter, providing that they are not abrasive.

Two models are available, the GP32 and GP50. Both are powered by a 1 hp motor, running at 2,900 rpm. The discharge size of the units is 1¼ and 2 in respectively. Capacities are some 57 gpm against a head of 5 ft or 10 gpm against 35 ft in the case of the GP32, and 85 gpm against 5 ft and 10 gpm against 38 ft with the GP50. *Industrial Pumps Limited, 20 Bentinck Road, Nottingham.*

SAW SHARPENING GRINDER

Fully Automatic



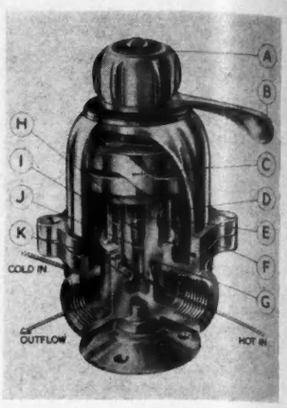
THE Merz-Universal Model 55 multi-purpose grinding machine, for straight and angular grinding, is fully automatic and suitable for both circular and band saws.

The fully automatic attachment is stated to be suitable for fitting to existing Merz machines operated by 3-phase motors. It is claimed that all types of teeth can be ground, with or without indexing discs. The machine is available for bench mounting or with a stand. Circular saws of from 6 to 25 in diameter may be ground, either straight or angular. The depth of tooth which can be accommodated is up to 1 in in the case of straight grinding and ½ in if the grind is angular. Pitch of teeth is up to 1 7/16 in if straight and 1 11/16 in if angular.

Capacity for band saws is up to 2 in in width; gang saws up to 3 ft 11 in and 6 in wide may be sharpened, and planer blades up to 24½ in or alternatively 33 in. Sprockets can be supplied for any pitch or width of mortising chain. Profile cutters with diameters from 2⅜ to 8 in diameter, angular cut up to 1½ in thick, straight cut up to 2⅜ in thick, with a maximum tooth depth of 2 in cash be handled. Power supply required is 3-phase 260/440V at either 50 or 60 cycles. *Whitehill Spindle Tools Limited, 12 Woodside Road, New Malden, Surrey.*

MIXING VALVE

Combines Thermostatic and Flow Control



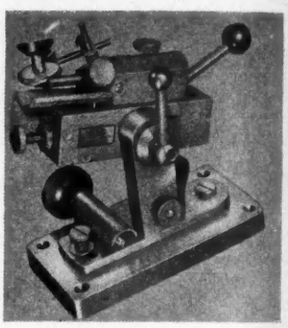
KNOWN as the Leonard 72 valve, this unit combines thermostatic control of water temperature with flow control.

It is claimed that combination of the two functions concentrically enable the need for non-return valves or separate inlet or outlet flow-control taps to be dispensed with, resulting in a compact valve with applications ranging from simple domestic showers to complex industrial processes. The flow control A operates like a simple tap, controlling volume. The temperature selection lever B maintains temperature irrespective of volume. Also shown in the sectioned view are the thermostat assembly C, the mixing chamber D, flow control spindle E, regulating port sleeve F, port pillar G, spindle hot seal H, spindle separator seal I, spindle cold seal J, and the upper and lower main seals K.

The valve is reported to operate satisfactorily under a minimum head of 5 ft and up to a maximum pressure of 120 lb. per sq. in. It is said to be able to cope with a pressure variation between hot and cold supplies of up to 5 to 1. Inlet and outlet diameters are both ½ in. The entire mechanism is comprised in two removable assemblies which are said to be easily cleaned and replaced. Two basic types are available. *Walker Crossweller and Company Limited, Cheltenham, Gloucestershire.*

ROUTER GRINDING ATTACHMENT

For Carbide Tips



THE Colton Mark II router grinding attachment is claimed to quickly and easily resharpen carbide tipped or high speed routers, panel cutters, and profile cutters in position.

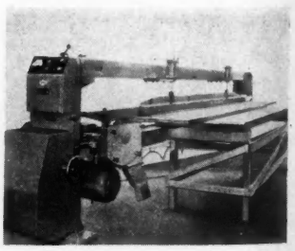
It is said that operation is simple and that when sharpening there is no grinding into the inner radius of the cutter. The attachment can be screwed to a suitable piece of flat board, which is then clamped to the router table in the usual way. The 1½ in diameter grinding wheel is then mounted in the spindle of the machine. The slide carrying the cutter which is being ground is inclined, this enables straight spoon bits to be ground to the correct inner curve. It is reported that the wheel will correctly follow inner curves of from ½ to ¾ in radii.

Four cutter arbors are supplied, of ¾, ⅛, ½, and 7/16 in diameter; metric sizes are also available. The three grinding wheels supplied are suited to high speed cutters, restoring chipped edges of carbide cutters, and honing the latter. A built in lubricator keeps the wheel moist during diamond honing.

The attachment is fitted with an angular scale and various stops; these enable the work to be quickly set up or reset should it be necessary to remove the cutter for examination during grinding. Routers from approximately ⅜ in to ¾ in diameter can be accommodated. The base size of the attachment is 9 in long by 4 in wide. *Colton and Company (Lapidaries) Limited, The Crescent Wimbledon, London SW19.*

PANEL SAWING MACHINE

Heavy Duty



LATEST addition to a range of panel sawing machines, the Type EU has a moving saw head the work being clamped pneumatically.

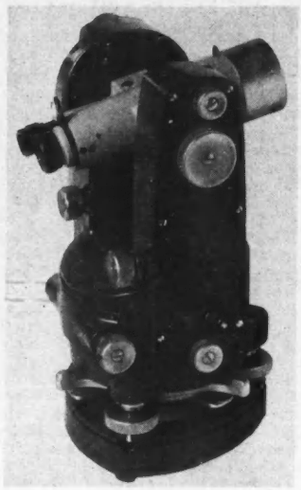
The tool is reported to be suitable for trimming normal single panels, for high-density panels, and for thin panels, including plastic laminates, in multiples. It is described as a relatively low cost machine for medium production requirements. Normally the machine is supplied as a self contained unit, without work support tables and guide fences; if required, support tables can be quoted for. By placing two EU machines at right angles, accurate squaring of panels is reported to be effected.

Two forms of machine are available, the EU/1 and EU/2, differing dimensionally. In each instance the maximum length of panel admitted is up to 16 ft, and the maximum width is as required. The greatest admissible thickness in the case of the first model is 1¼ in and in that of the second 3 in. Larger panels can be accommodated by arrangement. The diameter of the saw on the EU/1 is 14 in and on the EU/2 18 in. Cutting speed is dependent upon the material. Both model have a saw head feed speed in forward and reverse of 23 to 60 ft per min; the feed motor in both cases is of 1·7 hp while saw motors are of 7½ and 10 hp respectively. Pressure required for operation of the cylinders actuating the pneumatic clamps is 80 lb per sq. in. The net weight of the machine with a capacity of 10 ft is 2,436 lb.

The control panel includes an ammeter for indicating the load on the saw motor and the control circuit is interlocked. *Thomas White and Sons Limited, Laighpark, Paisley, Scotland.*

MICROMETER THEODOLITE

Easily Set Up



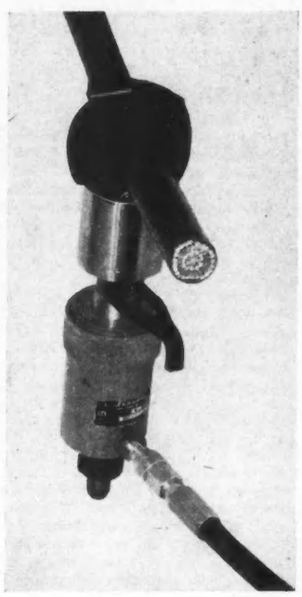
THE Stanley A1 optical micrometer theodolite is claimed to meet all the requirements of the traditional vernier theodolite and in addition to embody advantages.

It is claimed that all observations can be made without change of position by the observer. All optical and moving parts are enclosed and protected. The open micrometer scale is reported to read to less than 5 seconds by estimation. Compactness and lightness are also said to be features of the instrument.

The telescope transits both ends; focusing is internal and is possible down to 4 ft, fitted with open sights. The diameter of the object glass is 1·4 in, magnification ×20. Field of view is 2 degrees. There is interchangeability of the B3 diaphragm with 1/100 stadia. Circles are: horizontal 2⅜ in. diameter and vertical 2½ in diameter, both read to 20 seconds direct by optical micrometer. The steel centres are hardened and lapped. The independent circle axis is operated by repeating clamp. Spirit levels are: plate $\frac{1}{10}$ in = 1 min; altitude $\frac{1}{16}$ in = 30 sec. *W. F. Stanley and Company Limited, New Eltham, London, SE9.*

POWER-OPERATED CABLE CUTTER

Cuts up to 2 in dia.



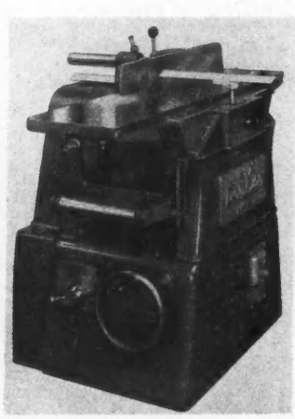
CAPABLE of cutting stranded copper and aluminium cable up to 1,000,000 cm and high voltage cable up to 2 in outside diameter, the CS 100 cutter illustrated is hydraulically operated.

It is claimed that the time required to cut a cable of the maximum size is 60 seconds, which time includes setting up the work. The cut leaves each of the strands cleanly severed. The unit is claimed to fit the majority of hydraulic knockout sets. A feature of the cutter is the ease with which it may be applied to cables in relatively inaccessible positions. When the cable has been inserted between the jaws, the blades quickly close to the cutting position. All wearing surfaces are reported to be hardened.

The unit has an overall length of 14 in and weighs approximately 13 lb. The operating pressure is 8,650 lb per sq. in, enabling the ram to exert a force of 12 tons. The device is unsuited to armoured cable. *Blackhawk Limited, 12 Brunel Road, Acton, London W3.*

WOOD PLANER

Surfacing and Thicknessing



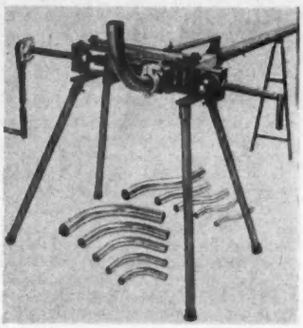
THE Type ES 12 in by 7 in surfacing and thicknessing machine is intended to meet the requirements of joiners, builders, and woodworking machinists for a machine of reasonable capacity.

Claimed to incorporate all modern improvements, the machine is reported to be able to plane and thickness timbers of all types and sections with accuracy. The top tables, fitted with steel lips, have an overall length of 48 in. Each table will lower ⅛ in; rebates up to ½ in deep and of any width may be machined. Scales give a direct reading of the cut. The cutter-block is of the two-knife circular safety type, mounted on ball bearings in dust-proof housings. Each knife is held in position by five hardened screws. In setting the knives small setting blocks, located on the periphery of the cutterblock are employed, in conjunction with leaf springs at the back of the knife.

The bottom table carries a graduated scale for quick thickness gauging up to depths of 7 in. The fence is adjustable for angles up to 45°. Front and rear guards are provided, the latter being attached to the fence. The speed of the cutterblock is 5,000 rpm and the two feed speeds are 15 and 30 ft per min. *Dominion Machinery Company Limited, Hipperholme, Halifax, Yorks.*

TUBE BENDER

With Mandrel Attachment



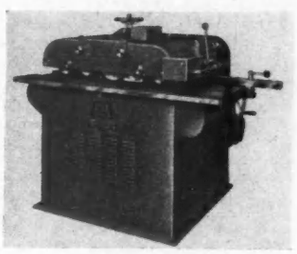
THE RP5A ratchet tube bender may be used as a compression or mandrel bender, and is said to be completely portable in both instances.

It is claimed that for the first time the advantages of a compression bender and a mandrel unit are incorporated in one machine. An indicator is fitted which determines the correct bending pressure to be applied, having regard to the class of tube which is being manipulated. Among the bends which are stated to be speedily produced are double setts, and saddle bends. Mounted on a stand which has detachable legs, the RP5A employs a rotary bending action obtained through the medium of a ratchet screw. The capacity as a compression bender is from ¼ in to 2 in diameter BS 659 copper tube, ⅜ in to 1½ in diameter electrical conduit, and ¼ in to 1 in nominal bore gas and steam pipe. It is said that in the case of copper tube bends to good commercial standards can be produced but, as is the case with compression benders, slight flattening and throating occurs, particularly on sizes above 1 in. When perfect bends in copper tube are required the mandrel attachment is used; it is reported that this can be fitted in under five minutes.

Separate mandrel heads, used in conjunction with standard formers, are supplied to fit ⅜ in to 2 in BS 659 tube. Bends so produced are said to be completely round full bore ones, free from wrinkling, flattening, and throating. *Hilmor Limited, Caxton Way, Stevenage, Hertfordshire.*

MULTI-BLADE LAMINATING SAW

Additional Uses



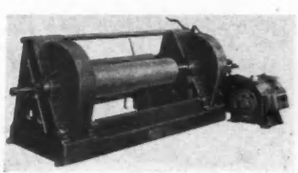
IT is claimed that the SM80 multi-blade laminating saw may also be employed as a strip saw, ripping saw, or parting saw. Additionally the machine is said to be suitable for use as an edger and for sawing all types of straight-edged material.

In addition to the claims made for its versatility, it is reported to be a machine with high rates of production. The maximum diameter of the saw is 11 in; the saw spindle speed is approximately 4,500 rpm and the saw spindle diameter 2$\frac{33}{64}$ in. The maximum sawing height is 3⅛ in. The feed belt has a width of 7⅞ in and a speed variable from 0 to 131 ft per min. The saw spindle motor is of 26hp, the power of the feed motor being 1·7 hp.

The saw spindle, running on SKF bearings, is of high-carbon steel and is dynamically balanced after fitting. The feed belt is made of cast links which form a continuous chequered unit sliding on a bed provided with longitudinal ground guides. A heavy throw-back guard, covers the entire table width. Four independent units guide the timber being fed in. On the feed-in side there is a spring-loaded support roller; after this there is a pressure plate for locating the wood to be sawn. The pressure plate is spring-loaded and parallel-guided so that the plate lies flush against the work-piece at all height positions. After leaving the saw the strips run on to a sectioned roller, the sections of which are independently sprung to enable them to follow the contour of the wood. A further roller holds the workpiece in contact with the feed belt. *Rye Machinery Sales (High Wycombe) Limited, 14 Pauls Row, High Wycombe, Bucks.*

ROTARY VENEER PEELING MACHINE

Power Dogging



THE Type GTC rotary veneer peeler is intended for logs up to 126 in in length and 66 in in diameter.

Independent motors are employed for power dogging and for power operation of the knife slide. Variable knife pitch and gearboxes give a thickness range from 0·25 mm up to 5 mm. The 6 in diameter spindles, in company with most of the main shafts, revolve on Timken bearings. Dogging is carried out by 3 hp motors at both ends; the log may also be dogged by using the main driving motor in conjunction with the brake band. The knife slide has a pressure bar, fitted with micrometric adjustment and arranged with tilting motions actuated by a handwheel and screw. Automatic knife pitch is provided. A lever drawback gives immediate access to the knife. The knife slide may be power traversed to and from the log, operation being by a 5 hp motor.

Thickness of cut is varied by an 8 speed gearbox in conjunction with a 2 speed box. Thickness may be varied between the sizes mentioned by increments of approximately 0·25 mm.

The machine lends itself to various methods of driving. The main one is by a variable speed commutator motor, of approximately 75 hp, giving a speed variation of 3:1. Other possible methods are the use of a variable speed hydraulic unit or, if changes are infrequent, an ordinary sc motor with change pole controller. All motors on the machine are controlled by direct-on-line push-button starters with cut-out switches to prevent over-running.

The Type GTC machine, which weighs approximately 25 tons and has overall dimensions of 24 ft long, 9 ft wide, and 7 ft 6 in high, is the latest and largest addition to a range of peeling machines. *John Pickles and Son (Engineers) Limited, Hebden Bridge, Yorkshire.*

500 TON FORGING PRESS

Self-Contained

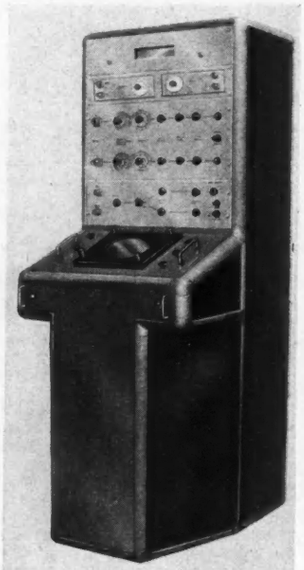
SELF-contained—requiring only a power supply—the forging press illustrated has a capacity of 500 tons.

It is claimed that the press occupies small floor space, the area required being 10 ft by 5 ft. Operation is reported to be simple. The ram guides, having faces radial to the centre line of the press, are reported to be unaffected by compression or expansion. This characteristic enables the top platen to be restricted laterally to 0·006 in movement at any part of the stroke. Maximum ram speeds in both directions are 740 in per min; the pressing speed which commences automatically when the ram contacts the work is 76 in per min. Press daylight is 36 in, the stroke is 16 in and the bolster 36 in square.

The fabricated units are stated to be of such rigid construction that the bed deflection is less than 0·001 in per foot, allowing for distributed off-centre loading up to 7 in from the centre. *D. L. Lombard and Sons Engineering Limited, 19 Grosvenor Place, London SW1.*

INDICATOR

For Internal Combustion Engines



THIS indicator has been designed and developed for use in internal combustion engine investigation and development work.

Compactly assembled, the equipment is stated to be easily operated. It is said to be suitable for use with resistive capacitive and inductive pressure or displacement transducers. The complete engine cycle, from which measurements of pressure and movement can be made, is displayed. The general form of the indicator is stated to allow for many uses outside the automotive industry requiring accurate measurements.

The engine indicator consists of a two-channel dc amplifier, engine synchronized time base, electronic camera shutter, degree marker and a two independent-beam cathode ray tube display. A range of transducers is available for diesel engine testing.

Diagrams may be expanded to × 10 the diameter of the cathode ray tube screen. *Rotax Limited, Chandos Road, London NW10.*

CALORIFIER

Vertical or Horizontal Types

KNOWN as the Type D Series 2, the non-storage pattern calorifier, a vertical example of which is illustrated, is the makers' Type D which has been redesigned.

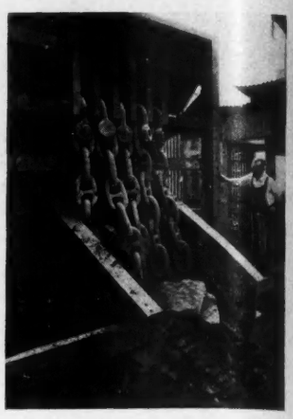
It is claimed that in its latest form the unit has increased efficiency, and is more compact, enabling a substantial reduction in cost to be effected. Construction conforms to BS 853:1960. The heating surface is formed from indented copper tubing. The tubes, arranged in batteries, are easily withdrawn for inspection; if required, individual tubes are readily removed.

Available in 12 sizes, these calorifiers are supplied in vertical or horizontal form. As redesigned working pressures up to 150 lb per sq. in on the steam side and 100 lb per sq. in on the water side are permissible.

The flanged branch connections for flow and return comply with BST-C; cold water supply, emptying, relief valve, and thermometer tappings are BSP.Tr. *Royles Limited. Irlam, Manchester.*

ELECTROMAGNETIC FEEDER

High Output



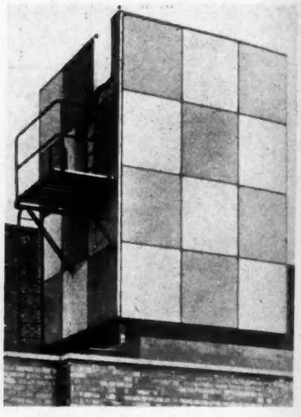
CAPABLE of handling run-of-quarry granite of up to 24 in cube, the Sherwen electromagnetically operated vibrating feeder illustrated is reported to be capable of an output considerably over 200 tons an hour.

The feeder is claimed to have a low power consumption and to have an instantaneous and infinitely variable control of feed rate. Wear is said to be very small, due to there being practically no sliding contact between the trough and the material. The feeder consists essentially of a trough which is vibrated by an electromagnetic unit. The low power consumption is stated to be due to the state of resonance which results from the trough and body assemblies being held together by an arrangement of leaf and coil springs under compression.

Unidirectional pulsating current, from a half-wave rectified ac supply, is supplied to the vibrator coils, resulting in a series of magnetic attractions between the magnet and the armature. Operation on a 50 cycle supply is at the rate of 3,000 vibrations per minute. Normally vibrations are applied to the trough at an angle of 20°, imparting an upward and forward movement in one direction and a backward and downward movement in the other. Rate of flow depends on the amplitude of the vibration. *General Electric Company Limited, Erith, Kent.*

WATER-COOLING TOWER

Architectural Appeal



THE induced draught asbestos-cement clad single-cell water cooling tower, illustrated, has a capacity of 15,500 gallons per hour.

It is claimed for towers of this type that the space required is one-half to one-third of the area required for a natural draught tower, and that the external appearance enables the unit to harmonize with the surroundings. The example shown occupies an area 10 ft 6 in square. Induced draught, derived from a fan located at the top of the tower is claimed to permit of a more even distribution of air over the base of the tower. Recirculation problems are reported to be reduced owing to the air leaving the top of the cooler at a high velocity. It is stated to be possible with this type of cooler to re-cool circulating water to within 5° of the wet bulb air temperature, and when necessary approaches of 3 to 4° can be catered for.

The cladding is available in contemporary and traditional designs; the sheets can be supplied in the whole BS colour range. Sheet surfaces are said to be durable and the coatings resistant to acidic atmospheres and to fading. Glazed panels and sheets of varying colours enable particular effects to be achieved. *Film Cooling Towers (1925) Limited, Chancery House, Parkshot, Richmond, Surrey.*

PLATE LAPPING MACHINES

For Unmachined Work

TWO new lapping machines, with plates of 48 in and 72 in in diameter, have been added to the Lapmaster range. The latter is the largest machine of this type in Europe.

The 72 in model illustrated is claimed to be of particular interest to motor and engine manufacturers, in that it enables such components as sumps, cylinder blocks, and cylinder heads to be accurately and economically surfaced. It is reported that improved methods of die-casting aluminium and iron render the lapping of large castings after a minimum of machining to be more economical than the machining methods formerly employed; in some instances castings may be placed straight on the lapping plate without any previous machining operations. Any metal, ceramics, and carbon are among the materials which may be lapped. Surface finishes from 1 to 5 μ in or less are attainable and flatness is accurate to millionths of an inch.

The four conditioning rings, mounted on the lap plate, maintain the plate in a flat condition. The work is normally placed within them, without any need for fixing; items up to 27½ in in diameter may be accommodated within each ring, four components being dealt with simultaneously. If it is required to handle larger items the conditioning rings may be removed, when items with face dimensions up to 52 in can be lapped.

The annular lapping plate has an outside diameter of 72 in and an internal diameter of 18 in, giving a lapping face width of 27 in. The plate, which revolves at 42 rpm, has a working height of 34 in. *Payne Products International Limited, Buckingham Avenue, Slough, Buckinghamshire.*

Companies

Inspiring Prospects for Crompton Parkinson

ALTHOUGH surveying the current year with some measure of caution, Mr. Albert Parkinson, M.B.E., the chairman of CROMPTON PARKINSON LIMITED electrical engineers and manufacturers, of Guiseley, Leeds, says that he believes there can be no doubt about the inspiring prospects which confront their own industry and that Crompton Parkinson "must and will" play their full part in its future.

Experience, he comments in a recent statement, shows that industrial progress and the use of electricity are almost synonymous. Every year, the generation of electricity in almost every country in the world shows a striking increase.

While the extent of the firm's outstanding orders is good, it is likely, owing to rising costs, especially in regard to wages, that most of these orders will necessarily have to be executed at profit rates which must be below those which the company have experienced in this last year and in preceding years. Furthermore, the consistency of demand which has existed throughout this last year will not, it is considered, manifest itself to the same degree in the coming year. This position will apply especially in the fields of traction and transformers.

A high proportion of their exports is destined for the Commonwealth and for what were British territories and the company's links, as manufacturers, with the Commonwealth, both under their own name and in conjunction with their partner firms, are, Mr. Parkinson considers, of vital importance.

For these reasons, any move which adversely affects the Commonwealth would be a matter of regret and concern for Crompton Parkinson. "It is profoundly to be hoped, therefore, that a way will be found of satisfactorily accommodating Commonwealth interests," if a closer liaison is to be made between Britain and the Common Market.

Changed Attitude to Nuclear Power

Mr. Parkinson says that his shareholders will have noticed Crompton Parkinson's decision to withdraw from ATOMIC POWER CONSTRUCTIONS LIMITED. That company have become part of UNITED POWER COMPANY LIMITED and the decision to withdraw was made when the reorganization took place.

In consequence, Crompton Parkinson's future interest in the development of nuclear power will be limited to that of supplying and installing equipment within their normal range of manufacture, and will not include the building of nuclear power stations as such. As a result of their period of membership of Atomic Power Constructions, however, the firm has acquired a wide knowledge of, and interest in, the generation of electricity from nuclear power.

Progressive reorganization of the firm's switchgear facilities has resulted in a decision to concentrate the manufacture of their entire range of switchgear at Chelmsford and, consequently, their Manchester works are in progress of being closed. Crompton Parkinson have every confidence that the step which has been taken will increase the effectiveness and efficiency of their switchgear production as a whole.

In the medium range of industrial motors, which are produced at their Guiseley Works, the output has been considerably increased and the demand has been consistent and buoyant. Fractional horsepower motor production at Doncaster has felt the effects of the somewhat daunting situation existing in the domestic appliances field. Fortunately, however, industrial demands for this class of motor have remained good.

It may be noted that the company's profits have expanded in all but one of the last ten years.

Textile Modernization

The Rochdale factory of DUNLOP TEXTILES LIMITED, has a continuous history going back to 1914 when two associated companies, Tyre Yarns Limited, and Fabric Weavers Limited formed a local directorate. Foundations for the factory at Castelton were begun in March of that year and the first roll of canvas was ready for delivery exactly one year later.

Always closely associated with the Dunlop Rubber Company, the venture was purchased by them in late 1916 and finally renamed Dunlop Textiles Limited in 1961. The final change followed the introduction of various fibres other than cotton for use in tyre and similar fabrics. At the present time cotton, Rayon, Nylon and Terylene are all being used in the mill.

Up to the last War the factory enjoyed a reputation for full employment and there was even a waiting list. Since 1945, however, the position has so changed that Dunlop have had to site new factories at Hindley Green, Thornliebank, Dunfermline, Bidston and Londonderry, to find labour so that output requirements could be met.

At Rochdale a steady progress in modernization is being maintained with the basic ideas of improvement of product; economies in labour; larger packages throughout the processes; use of automatic machines where possible; improved worker amenities and improved production flow. Progress received a set back due to a disastrous fire in February 1960 which damaged some of the new machinery. The complete scheme is estimated to cost more than £2½ million and up to the present more than £1 million has been spent.

In an effort to attract more labour, the company installed in 1948 a complete nursery so that married women with small children can attend. This has proved very popular, both with parents and children. It is fully equipped with toys, rest cots, and canteen. They now regard the nursery as a necessity. Most of the new machinery being installed is automatic or semi-automatic in operation so that the number of minders required is less. The new plant will also increase the overall capacity of the mill. Improved cleanliness and proper air conditioning are features of the areas where modernization has progressed.

Two Thousand Jobs in Prospect

STANDARD TELEPHONES AND CABLES LIMITED, telecommunications engineers, Aldwych, London WC2, have decided to establish a new factory at Monkstown, Northern Ireland, on the north-west shore of Belfast Lough, some eight miles from Belfast.

The project involves the immediate occupation of an existing new building of some 50,000 sq. ft of floor space in order to provide facilities for the training of factory operatives and to commence production. It is being undertaken under the auspices of the Northern Ireland Government's scheme for aiding employment in Ulster.

Stage two of the project will be to erect on an adjacent site of some 20 to 30 acres, a factory with around 150,000 sq. ft of floor space, which when in full production, will give regular employment for 2,000 persons.

The main products to be manufactured at the new factory will be telephones and telephone-exchange equipment of which the company are major suppliers to the Post Office in this country and to many telephone administrations overseas. It is intended that the factory shall form part of the company's telephone switching division, thereby supplementing the productive capacity of the division's main factory at New Southgate in North London. This division, it may be noted, also possesses a manufacturing unit at Treforest in South Wales.

Standard Telephones are currently supplying much of the equipment required for the introduction of Subscriber Trunk Dialling in Great Britain. They are also one of the group of manufacturers cooperating with the British Post Office in the development of electronic telephone exchanges.

A New Subsidiary for Edgar Allen

After having held a minority interest in the SHEFFIELD HOLLOW DRILL STEEL COMPANY LIMITED, Carbrook, Sheffield, for many years, EDGAR ALLEN AND COMPANY LIMITED, Imperial Steel Works, Sheffield, have now acquired the remainder of the firm's issued capital. Sheffield Hollow Drill thus become a wholly-owned subsidiary within the Edgar Allen group.

Activities of the new subsidiary include, among other manufactures, the production of carbon and alloy steel bars within the range of ½ in to 3 in rounds, squares, hexagons and octagons, as well as special mining sections such as turbines and diamonds; hollow and solid mining steel bars, hollow bars for engineering purposes; hollow and solid staybolt steel and alloy steels; finished drills and pneumatic tools; and concrete breakers and allied tools.

Colt Ventilation Penetrate Iron Curtain

A promising example of how British firms are supporting the nation's export drive is furnished by COLT VENTILATION LIMITED, Surbiton, Surrey, who have secured during recent months a contract for certain construction work at a factory near Bucharest for the Rumanian People's Republic.

The first part of this contract includes the installation of Colt clear-opening natural extractors and powered inflow units on the foundry roof. The factory is engaged on the production of baths and radiators. As will be seen from the accompanying illustration, taken when the work was in an advanced stage of completion, there was a fairly extensive area of roof to be dealt with.

Colts, who specialize in industrial heaters and in the production of domestic and industrial ventilators, are due to commence work on the second part of the contract, industrial heating installation, next month.

Clear-opening natural air extractors and powered inflow units being installed in the roof of a foundry near Bucharest. This is part of a ventilation contract secured by Colt Ventilation Limited from the Rumanian Government.

Users of Slow-Rusting Structural Steels

Here are some uses of copper-bearing mild steel such as can be specified to BS15:1961, and of Cor-Ten steel—a copper-bearing low-alloy steel with better strength than mild steel.

THIS last summer, the Copper Development Association published a booklet on the subject of copper-bearing steels for structural purposes. It was compiled on the suggestion of the chairman (from 1944 to 1959) of the British Iron and Steel Research Association's Atmospheric Corrosion Sub-Committee, part of whose researches are held to show that the addition of a fraction of a per cent of copper to any structural steel will give it slow-rusting properties.

Potentially, this conclusion has always been very interesting. But it is not easy to find engineering firms who have made use of it, nor to detect any particular enthusiasm amongst steel makers to offer structural products with a slow-rusting label or specification, that is, until one progresses to the copper-bearing Cor-Ten steels and other low-alloy structural steels.

An attempt has been made by ENGINEERING to find users of copper-bearing mild steel such as could be specified in BS15:1948. The result of this is recorded here. The small number of applications and the reluctance of engineers to be associated with the benefits of copper additions to mild steels suggests that if a steel is sold as slow-rusting, then it must be possible to discern the advantage in real terms rather than in laboratory per cents. Low-alloy Cor-Ten forms a fine adherent rust and the rate of rusting is reputed to be reduced in most instances by a factor of about four. This difference is discernible. But it is not so easy to detect an improvement by a factor of about two from a straight copper addition to a mild steel, especially when the rust does not look much different from normal and is going to vary in any case.

It is worth noting that the specification of copper-bearing mild steel to BS15 has now been made easier by the revised layout and nomenclature adopted in the new version of this standard published in recent weeks (BS15:1961 " Mild Steel for General Structural Purposes ").

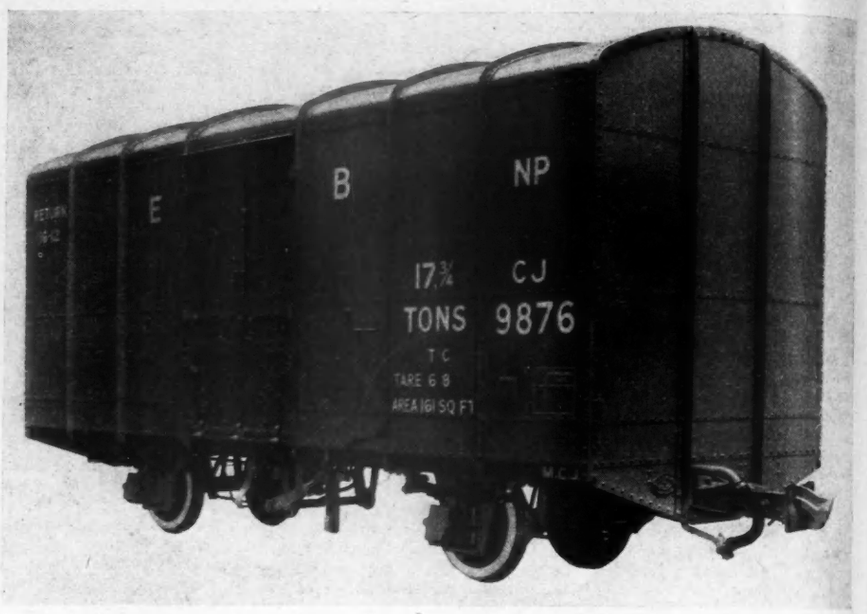


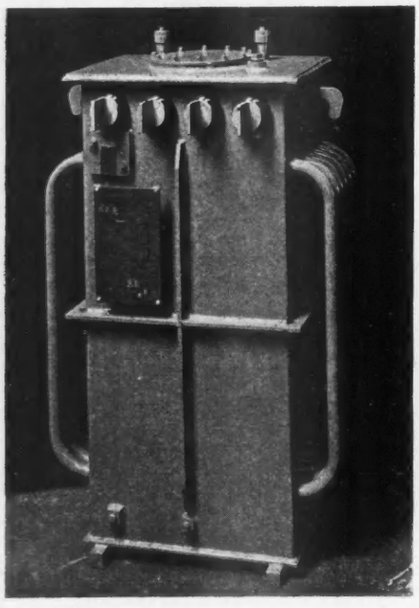
Fig. 1 Railway wagon for overseas.

There is a choice of specifying grades 1, 2 or 3, the last two containing 0·20/0·35 and over 0·35/0·50 per cent of copper, respectively. Where no reference to a particular grade is made in the order the British Standard deems that " Grade 1 will be supplied " with no copper content.

The names and addresses of firms who make copper-bearing mild steels or Cor-Ten steel are shown in the table on page 683. Most of those firms who produce the first product say that they supply it only to order, and on the question of cost, the Copper Development Association have discerned that a premium of about 5 per cent is charged for the copper addition.

It might yet prove rewarding to start using and asking for copper-bearing structural steels, especially if reasonable delivery dates can be established and stocks of well used forms can eventually be obtained through the stockist.

Fig. 2 Distribution transformer to US standards.



Copper-Bearing Mild Steel for Distribution Transformers

English Electric Company say that in the USA, copper-bearing mild steel is used for the tanks of small transformers of the type used in the distribution of electricity.

A common practice in North and South America is to install distribution transformers in pits under the street. As such installations are subjected to periodic flooding, the transformers are designed to be completely submersible. The transformers, one of which is shown in Fig. 2, are completely sealed to prevent the ingress of moisture to the interior and the use of copper-bearing steel retards corrosion of the external tank surfaces.

The appropriate ASA/NEMA specification for subway transformers states that the transformer tank walls and any cooling tubes shall be of copper-bearing steel having a thickness of $\frac{3}{16}$ in and that covers and tank bottoms shall be $\frac{1}{8}$ in thick.

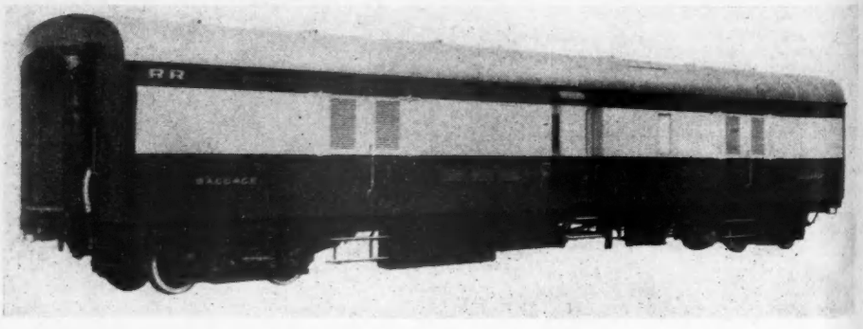
English Electric say that they have manufactured large numbers of subway transformers to American standards during recent years at their Liverpool Works, in ratings from 50 to 500 kVA. Copper-bearing steel in accordance with BS15:1948 has been used to meet the requirements specified.

After fabrication of the tank etc., all external surfaces are shot-blasted and painted with a lead primer before being finally painted with undercoat and final coat.

Copper-Bearing Mild Steel for Rolling Stock

Mild steels with a copper content of between 0·25 and 0·35 per cent are now regularly specified by a number of railways for exterior body panels and floor sheets, say Metropolitan-Cammell Carriage and Wagon Company. Such steels are generally employed because of their superior resistance to atmospheric corrosion, they add, and the steels are particularly used in conditions where vehicles are to see service in

Fig. 3 Railway coach for overseas.



the salt laden atmosphere of tropical coastal regions or meet similar attack due to the transport of bulk salt or salted foods.

Two vehicles recently constructed by Metropolitan-Cammell are shown in Figs. 1 and 3. The four-wheeled covered goods wagon is one of 2,000 being supplied for service on the metre gauge lines of Pakistan Railways. It embodies lower body and floor sheets in copper-bearing mild steel.

The guard's and baggage van for Rhodesia Railways employs the same copper-bearing material for roof and bodyside panels.

Metropolitan-Cammell comment that generally this type of steel is used by railways to reduce the effects of corrosion in applications which economically do not justify the greater increases in cost which would result from selection of low alloy steels or other materials exhibiting higher resistance to corrosion.

Uses of Slow-Rusting Cor-Ten Steel

Cor-Ten Steel in Cold-Formed Sections

The use of Cor-Ten corrosion-resisting high-tensile low-alloy steel strip has been an important factor in the development of cold formed steel sections for structural purposes, say Metal Sections. High strength has enabled the designer to use thinner sections resulting in a reduced deadweight of the building structure and subsequent savings in erection, foundation and other site costs. Corrosion resisting properties more than four times those of normal structural steel have enabled the designs to resist attack due to conditions of atmospheric pollution or chemical processes with perfect safety even though the thickness of the material is considerably reduced in the structural design from that usually employed in other forms of construction.

Cold-Formed Cor-Ten Sections for Building Structures

Metal Sections say they have used Cor-Ten steel in the fabrication of standard building components with great success. The building shown in Fig. 4 was the first complete steel structure in Cor-Ten steel strip made in the U.K.

This structure consisted of three pin portal frames 75 ft in span and 22 ft high at the eaves rising to 36 ft at the centre of the span. The building covered an area of nearly 100,000 sq. ft and was manufactured from cold-formed sections not exceeding 10 swg in thickness. Metal Sections say that the components were completely prefabricated to precise engineering standards by means of metallic-arc and resistance welding processes. They add that the choice of Cor-Ten steel for this building reduced the weight and site costs and enabled the occupiers to extend the maintenance periods to twice that of a normal structural-steel building.

Cor-Ten Steel for Aircraft Hangar Doors

An example of precision fabrication was provided by the construction of 48 sliding doors for the new wing hangar for BOAC at London Airport, see Fig. 5.

The structural framework for each door was made from cold-rolled sections in Cor-Ten steel strip by Metal Sections. Each door, measuring 32 ft high by 23 ft 6 in wide by 1 ft thick, was made in three parts consisting of a right-hand and left-hand wing section with a parallel centre section. The frames were arc-welded by the metallic-arc welding process to the precise limits of $\pm \frac{1}{8}$ in on overall dimensions and $\pm \frac{3}{16}$ in on flatness.

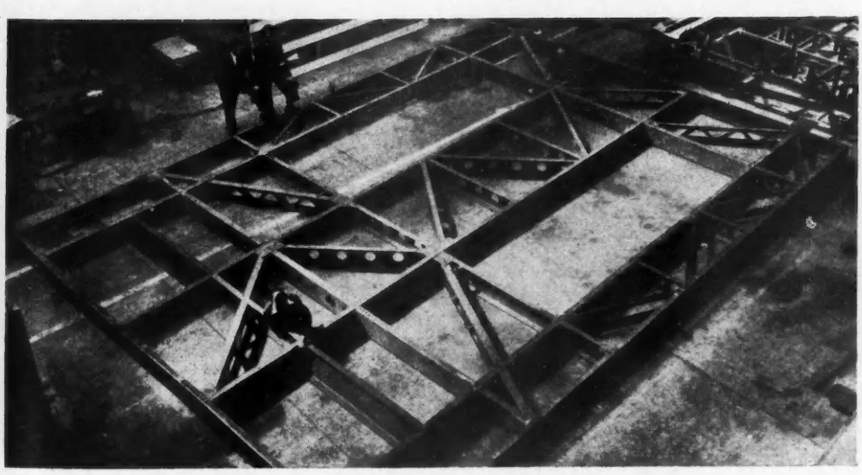
Fig. 4 The whole structure is made from Cor-Ten.

The frames were then delivered to Morfax Limited by road transport and bolted together prior to the fitting of the aluminium cladding, traction equipment and other finishing accessories.

Metal Sections comment that the selection of Cor-Ten steel for the framework was of primary importance in saving on the initial deadweight of the doors as the high yield point stress of 22 tons per sq. in enabled the designers to produce the framework in 10 swg (0·128 in) material. Welded construction also reduced the weight by eliminating the use of gusset plates, except at the jointing and suspension points, to such an extent that the door structure weighed only $1\frac{3}{4}$ tons.

After fabrication, each part of the door framework was thoroughly degreased, deep-phosphated and painted with a red oxide zinc chromate primer which was followed by a coat of bituminous paint on the contact areas between the steel framework and the aluminium alloy cladding to resist any possibility of anodic corrosion. Metal Sections add that this treatment, in addition to the corrosion-resisting properties of the basic Cor-Ten steel, was regarded as sufficient to eliminate any maintenance on the door structure during its estimated life of 20 years.

Fig. 5 Door structure weighs only $1\frac{3}{4}$ tons.



Makers of Slow-Rusting Steels

	Copper-bearing mild steel	Cor-Ten
Appleby-Frodingham Steel Company Limited, *Scunthorpe, Lincolnshire.*		★
Consett Iron Company Limited, *Consett, County Durham.*	★	
Llanelly Steel Company (1907) Limited, *PO Box 1, Llanelly, Carmarthenshire.*	★	
Richard Thomas and Baldwins (Sales) Limited, *47 Park Street, London W1.*	★	
Skinningrove Iron Company Limited, *PO Box 1, Saltburn-by-the-Sea, Yorkshire.*	★	
South Durham Steel and Iron Company Limited, *PO Box 16, Cargo Fleet Iron Works, Middlesbrough.*	★	
Steel Company of Wales Limited, *Port Talbot, Glamorgan.*	★	★
Steel Peech and Tozer Company Limited *PO Box 90, The Ickles, Sheffield 1.*		★
Workington Iron and Steel Company Limited, *PO Box 15, Moss Bay, Workington, Cumberland.*	★	

Cor-Ten Steel Tubes for Power Station Airheaters

One of the problems facing the boiler design engineer in his search for higher efficiency is that of reducing exhaust gas temperatures without incurring excessive penalties of maintenance of the airheater due to corrosion by moist sulphur-bearing gases, say John Brown Land Boilers. The corrosion problem is worst in that section of the airheater where metal temperatures are at their lowest, i.e. where the heating surface is traversed on one side by outgoing cooled gas and on the other by incoming cold air. One method of overcoming this problem is to make the " cold end " of the airheater of some corrosion-resistant material.

In the case of the tubular airheaters designed and built by John Brown Land Boilers for the Elland power station of the CEGB, Cor-Ten steel was chosen.

The airheater is a three-pass design, the final pass being shown in Fig. 6. The whole of this section is traversed by cold incoming air travelling across the tubes.

John Brown Land Boilers say that after about 24 months of operation no corrosion troubles have been experienced, whereas it has been known for mild steel used in similar applications to fail after relatively short periods of time.

Fig. 6 Cor-Ten tubes are outliving mild steel ones.

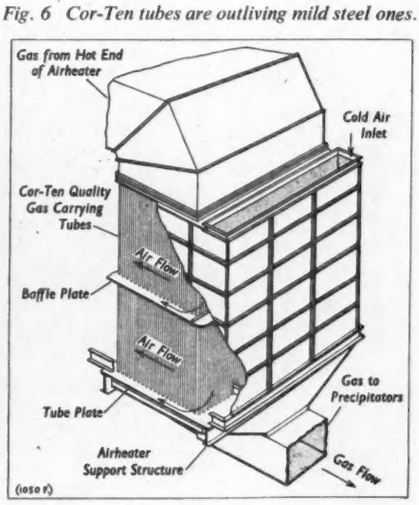


Fig. 1 The 550 ft long new welding shop extensions built at a cost of £500,000. Two cranes give a combined maximum lift of 125 tons.

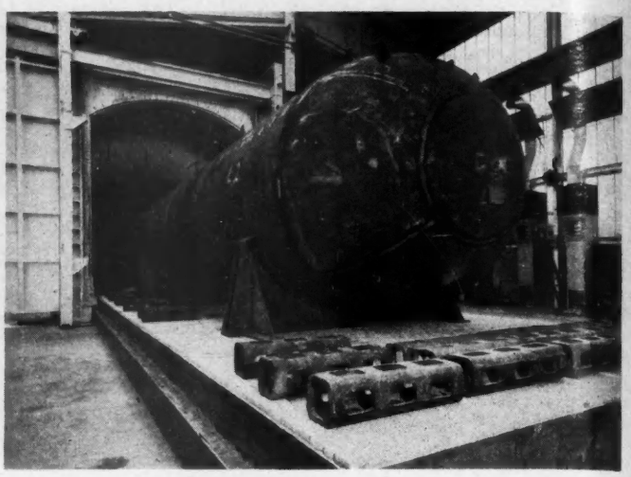


Fig. 2 A 60 ton storage vessel emerging from the stress relieving furnace, which is believed to be the biggest permanent furnace of its type in Europe.

Stepping Up Large-Scale Fabrication

In recent years, there has been a major growth in production techniques and capacity in the manufacture of large fabricated pressure vessels. Now, a leading producer has opened up new facilities which increase the national productive capacity by ten per cent.

SINCE the last war, over £4 million has been spent on redeveloping and extending the Whessoe Works at Darlington. Now, the company has completed £500,000 extensions to the welding shop (Fig. 1) in order to meet the increasing demand from industry for heavy shop-built pressure vessels. It is understood that this new installation will increase the overall UK capacity for this type of work by something like 10 per cent.

At the same time, one of the shops previously used for the production of pressure vessels has been freed for the manufacture of heat exchangers for petroleum and chemical process plant. This extension and re-allocation of resources, besides increasing the output vessels and the size of vessels, has doubled heat exchanger output.

In developing their manufacturing facilities in this way, the company are maintaining the policy of adapting their resources to meet changing demand, a policy which has been pursued since the firm was founded, as an ironmongery shop, in 1790. The company became interested in railways as the industrial revolution gathered momentum, and until about 1860, designed and manufactured locomotives. One famous product of this period was the " Derwent," a locomotive which now stands on Darlington station.

Since the 1880's the company has supplied oil storage tanks and process plant to the oil industry. During the last two decades it has taken the opportunity of extending its interests in the heavy pressure vessel field and in the storage of liquefied gases. Notable achievements have been: building the first nuclear reactor pressure vessels at Calder Hall (since then 14 others have been built or are being built, the latest being at Dungeness); winning the first export order, worth £1·2 million, for another nuclear reactor vessel for the Italian station at Latina; and building the first liquid methane tank to be used in this country.

Already, the new welding shop is handling, among others, vessels for a £900,000 contract received earlier this year in the face of fierce international competition, for a crude oil conditioning plant to be exported to India. Other vessels being manufactured are destined to hold liquid oxygen for steel processing.

The new welding shop is the largest single shop in the works. It is 550 ft long, 86 ft wide and 54 ft high to the top of the building and 30 ft to the crane rail. There are two overhead gantry cranes giving a maximum combined lift of 125 tons. Further crane capacity is provided by a 10 ton hoist with a travel of 80 ft which carries it over a bogie that supplies the shop with material by a side door. This bogie is loaded outside the building by a semi-goliath crane, of 10 tons capacity and 25 ft rail span, serving an adjacent storage area.

A particularly interesting feature of the shop is a new stress relieving furnace (Fig. 2) which, at 85 ft between doors and 18 ft wide by 18 ft high to the spring of the arch, is said to be among the largest permanent furnaces in Europe. The bogie serving it will carry 100 tons over one-third of its length or a total load of 200 tons. Heating is by towns gas and the temperature range is from 400° C to 1,150° C.

Next to the stress relieving furnace is a 100 ft long X-ray compound. This is designed to give full radiation protection from a million volt X-ray source, thus giving a very wide safety margin since the largest set at present in use in the shop has a 400 kV source. The compound is served by two bogies together capable of handling and rotating a 100 ton vessel. Alongside the compound are X-ray and furnace control rooms, and metallurgical testing facilities.

COORDINATION WITH BUILDERS

Another feature of the welding shop is the use of welding heads with columns and booms on rails operating over a matrix fitted with manipulators which can be fitted in any position in the matrix. Each set of rotators can handle vessels under construction up to 50 tons in weight, and two sets of rotators can be coupled to handle weights of up to 100 tons. On the floor of the shop is a large plating block which is used to ensure correct alignment of components during the early stages of fabrication. Vessels are normally welded both inside and outside, and Fig. 3 shows an example of automatic welding by the submerged arc process on the inside of a liquid oxygen storage vessel.

During building of the new extensions, it was essential that manufacture of vessels should continue without interruption, so that it was vital to coordinate Whessoe's production schedules with the construction programme of the civil engineering contractors, Bovis Limited. This detailed coordination, in fact, has been a characteristic of the whole post-war rebuilding programme, and new buildings have been built around the company's normal engineering processes. Thus, they have been tailor-made to suit manufacturing requirements and, in addition to making possible continued production throughout the construction programme, have provided an efficient final layout. An example of the cooperation between production and civil engineers is the fact that welding began before the stress relieving furnace had been completed.

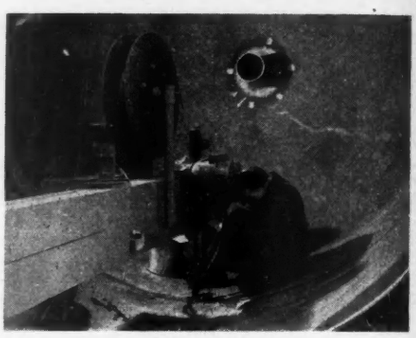


Fig. 3 Automatic welding by the submerged arc process on the inside of a liquid oxygen tank.

Work began on the foundations of the shop in 1959 and the Bovis operatives sank a total of 280 piles, each of them 17 in in diameter and 35 ft deep. About 2,000 cubic yards of concrete were used in the shop floor, and the roof needed 4,000 sq. yd of reinforced asbestos tiles and 4,000 sq. yd of fire-resistant insulation board. More than 200,000 bricks were also used. The shop's 800 ton structural frame was cladded with 10,000 sq. ft of aluminium sheet and 60,000 sq. ft of wired glass.

Another instance of cooperation between the factory management and the construction contractors was that early delivery of the two overhead crane carriages enabled the latter to use a time-saving scaffolding system for work on the roof. The crane carriages, when placed in position on their tracks, provided a scaffolding platform giving access to the roof, and electric winches were used to move the whole block along the entire length of the shop. This technique not only saved scaffolding costs and erection time, but also left the ground clear.

With the extra manufacturing capacity provided by these extensions, it is to be hoped that the company will be able to step up their already commendable export record. At present about 30 per cent of the £6 million annual throughput at Darlington is for export.

Whessoe Limited, Darlington, Co. Durham, England.

Phosphate Coating for Cold Forging

Phosphate coatings—better known as corrosion preventatives and as paint and varnish bonds—have an important use as an aid in the cold forging of steel, a process which was used for armaments manufacture during the war and has since been developed commercially. It is very attractive in that (a) the work-hardening involved improves the tensile strength of the steel and (b) the accuracy and good surface finish obtained often make further machining unnecessary, thus giving considerable savings in material.

To prevent metal pick-up during the severe metal deformation introduced by the process, it became necessary to develop an adequate lubricant. The most successful lubricant is phosphate coating impregnated with oils and soaps and, indeed, it is probably true to say that modern cold forging could not have become a practical and economic proposition without this method of surface treatment. The porosity of phosphate coating is one of its most important properties as it provides an excellent base for the retention of oils and other lubricants. A well phosphated surface is said to absorb 13 times more oil than an untreated one.

The plant required for phosphating usually consists of a series of in-line tanks, normally linked by overhead conveyor and containing the different solutions needed in the process. A typical sequence for handling workpieces would be as follows:

(1) Degrease and/or pickle. Dirt or irregularities would soon cause tool wear. Where pickling is necessary to remove scale, the usual solution is 10 to 15 per cent sulphuric acid at 70° to 85° C.
(2) Rinse in cold running water.
(3) Rinse in warm and hot water.
(4) Carry out actual phosphating, by pouring, spraying or immersion, the most commonly used phosphate being zinc phosphate.
(5) Rinse in cold running water.
(6) Rinse in hot water or lubricant.
(7) Dry at 100 to 150° C.

An in-line system of carrying out the above operations has drawbacks, however, in that it takes up much floor space. For this reason, the Colforg " Carousel " rotary surface treatment plant has been developed. Basically, this plant consists of a circular tank with a number of separate segments and a hydraulic ram supporting a framework of arms from which are hung metal baskets carrying the workpieces. The baskets are loaded and dispatched automatically and the whole central column (or hydraulic ram) is made to rotate at intervals to carry the parts from stage to stage in the process.

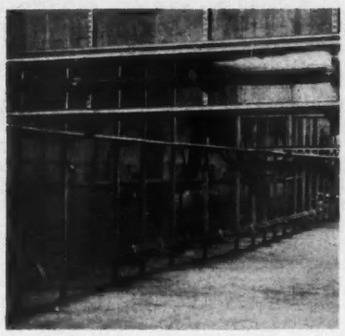
Cold Forging Ltd., 29 Hanworth Road, Sunbury-on-Thames, Middlesex.

Steelworks Uses Spur Cable Racking

The new £1¼ million continuous casting plant at Barrow Steelworks has a complex system of power supply and control, the cabling for which includes a 33 kV supply to the 10 MVA arc furnace transformer, a 6·6 kV supply, multi-core control cables and low voltage supplies. This, obviously, involves a considerable amount of cabling, and spur cable racking has been used to support these cables in the sub-station basement (as shown in the illustration) and in the adjacent cable races.

The cable racking system consists basically of slotted steel channels into which cantilever brackets are fitted at any desired height, at 1½ in intervals. Single channels can be bolted to walls or steelwork, or two channels can be bolted together to form rigid box-section members. These double-sided uprights are suspended from the ceiling by suspension brackets, or form floor-to-ceiling pillars using easily installed fittings.

In this particular application, fifty ceiling-



The spur cable racking system in the sub-station basement at Barrow Steelworks.

suspended units carry fifteen runs of overhead cabling, each 24 ft long; seventy-three floor-to-ceiling units carry twelve runs, each 80 ft long; and eighty-one wall-mounted racks carry twenty runs through the cable races for distances of from 40 to 60 ft. A simple bolting system on the brackets fixes standard cable trays or holds a spur top plate for fitting single and double tiered cable cleats, trefoil clamps and supports for uncleated cables.

All the components of the system are precision made, pre-drilled and hot-dip galvanized so that erection time is reduced to a minimum and painting is unnecessary. Flexibility is another important feature of spur cable racking, and at Barrow all the cable runs can be duplicated simply by adding further brackets to the existing uprights.

Being of unit construction, the system can normally be supplied by the manufacturers, Savage and Parsons, on a comparatively short delivery time. At Barrow, most of the equipment was delivered within a month of receipt of final instructions. There are other installations at Rugeley Power Station and at Milford Haven Refinery.

Savage and Parsons Limited, Watford, Hertfordshire.

Guidance on Computers and Production Control

The Institution of Production Engineers have now published a report, " Computers and Production Control " (price 7*s* 6*d*), on the findings of the sub-committee appointed two years ago to investigate the possibilities of applying computers for production control in the manufacturing industries. Membership of the sub-committee was not limited to production engineers, and, under the chairmanship of Mr. L. W. Bailey, it included non-members of the Institution.

In their report, the sub-committee set out to give an appreciation of the capabilities and the limitations of the various types of computers: to define production control (less easy than it sounds) and its applications; to assess, in the light of the above appreciation and definitions, the technical possibilities of using computers in production control; and, of prime importance, to make an economic assessment of such computer systems.

After full consideration of these points, the sub-committee came to the following broad conclusions:

(1) Although the applications of computer systems to production control are still rare, the use of computers offers an effective tool in the solution of production control problems or the development of improved systems.
(2) There should be careful evaluation of the considerations outlined in the report before any major decision is made on the acquisition of production control equipment.

In carrying out the evaluation referred to in the second of the above conclusions, the sub-committee felt strongly that more use should be made of the modern mathematical methods of decision making which come under the heading of operational research (ENGNG., 17 Nov., p. 652). At this stage, computer simulation is often useful in trying out different hypotheses on the theoretical model which characterizes operational research techniques. Even where it is concluded, in the case of a particular application, that a computer system is not appropriate, the investigation is likely to be of real value in demonstrating the possibilities of the company's organization and systems.

However, in the case of a small company, it might well be an economic proposition to hire computing time from a service bureau. Such an arrangement might also be appropriate in a large company until the building up of a load of work big enough to make the purchase of an installation economically justifiable.

An appendix to the report gives interesting case studies on (*a*) the application of a computer to sales scheduling; (*b*) the use of hired time for production control in a small textile company; (*c*) production control of electronic equipment; and (*d*) (to disprove that business about a prophet in his own land) production control of computer manufacture.

New Factory for Central Heating Ductwork

The increasing popularity of warm air central heating systems in this country has led to the setting up, in Essex, of a small factory which, using Canadian plant and experience, is now producing the ductwork required for such systems. Four Canadian heating engineers established the British company in July of this year and a month later it was in production.

Within a year it is expected to reach full production—10,000 to 12,000 sets of ducting per year—with a staff of about 60 local employees, all of whom will have been trained in the use of special high-speed equipment. Initially, the entire output will be taken up by the home

Part of the open-plan shop floor.

market but the company are also setting their sights on the Common Market countries.

Flexibility of warm air systems demands equal flexibility in the ductwork used, but standard items being produced include round pipe, rectangular cross-section ductwork, terminal fittings for the ducts, and an ingenious elbow joint which can be adjusted to any angle between five and ninety degrees. Production lines for all these products run in parallel on a single open-plan shop floor (part of which is shown in the illustration), and all components are produced from sheet steel.

Among the plant are two machines which, in two short-cycle operations, turn a length of metal pipe into an adjustable elbow joint. After cutting, rolling and riveting, the pipe is fitted into a circular jig and driven through two cutting wheels which cut it into four segments. When the cut pipe is placed in the second elbow machine, the segments are bonded together to form adjustable elbows. These machines are capable of producing 350 elbow joint units per day.

Air Flow Heating Supplies Limited, Bruce Grove, Wickford, Essex.

XUM

On the Shelf

By Frank H. Smith

As an engineer friend and I walked through one of the Hyde Park Corner subways, much drilling was going on on one of the walls, behind a canvas screen. We wondered what went on and he thought they might be cladding the walls. What is this verb that engineers have coined—to clad? Alclad I can take, since it is clad in aluminium, but clad is the past participle of to clothe so how can you clad something? It's not good enough. They'll have to think of something else. (It's about time the Editor had some letters about me.)

I remember doing a little piece about two articles in the *Unesco Bulletin for Libraries* on applications of the Universal Decimal Classification by Barbara Kyle and B. C. Vickery. These have now been wedded (the articles, of course) as a booklet *The Universal Decimal Classification: Present Position and Future Developments*, at 3*s* and HMSO " do " it.

With people buying and selling houses in all directions it is possible that some may like to by-pass solicitors (fools that they would be) and try mugging it up in Evans's *Buying and Selling a House* (Stevens, 11 New Fetter Lane, London EC4) ; 3rd edition, 14*s*.

The November number of the *Journal of the Royal Society of Arts* contains the text of the three Cantor lectures which, this time, deal with our latest form of information presentation—" The Presentation of Science and the Arts on Television." Tom Margerison deals with science, Basil Taylor (Royal College of Art) with the visual arts, and Lionel Salter (BBC Television) with music.

I expect many of you have had experience of those *ghastly* but practical envelopes that the Americans use for packing books which, if you happen to slit them injudiciously, send clouds of flock mattress all over the room. (And one usually does open them injudiciously because the paper is some tar-impregnated material that defies anything blunter than a scimitar.) Well—they've now infiltrated here and my first experience was from Pilkingtons. For shame, Messrs. P.—these envelopes are not stuffed with glass fibre!

How are you with your nuclear reactors? From the Technical Information Extension, US Atomic Energy Commission, PO Box 62, Oak Ridge, Tenn., you can get a 27-page free booklet *Nuclear Reactors built, being built, or planned in the United States as of June 30 1961.*

The latest in HMSO's " Choice of Careers " series (No. 95) looks like a spot of mouth-to-mouth artificial respiration. It is *Shipbuilding and Ship Repairing*, but it should have great appeal to a youngster (boy or girl—there's room for both) who is not struck open-mouthed at the sound of a jet (though that's not all that fascinating at the moment as a career-prospect is it?) For my money you can keep your aeroplanes as long as there's a ship about.

The Sheffield City Libraries consistently send me their lists of accessions, and the latest contains a list of typical questions dealt with by their Department of Commerce. While this list makes the King William's School Christmas quiz look like the entrance exam to a primary school it does highlight the side of librarianship which makes all the drudgery of cataloguing and indexing worthwhile.

My friend the librarian of the Royal Aeronautical Society is a bit of a stickler for the refinements of life, and he tells me that he will resist as long as he can the temptation to buy an American item, the publicity material for which came to him addressed " Royal Aero Society, Librn. 4 Hamilton Pl. London W.1." Abbreviation is, he feels, all right in the right place. He feels that Librn. is an attempt to cut him down to size and he resents it. So, 329 West 41st Street, New York 36, please note.

Using Boolean Algebra

Boolean Algebra and Its Applications. By J. ELDON WHITESITT. *Addison-Wesley Publishing Company, Reading, Massachusetts and London.* (51*s*)

This is an excellent book. The author writes with a natural teaching style which is simple and straightforward. The book introduces the subject of Boolean algebra from four main viewpoints: set theory, symbolic logic, switching theory, and probability theory. For each application the central topic, Boolean algebra, is developed from first principles in a manner requiring a minimal formal mathematical background.

The book begins with an introduction to set theory, and the correspondence of Boolean algebra to the algebra of sets is developed. An intuitive, geometrical approach is used here which serves to orient the student for the rather more rigorous introduction which follows. The next chapter gives an axiomatic development of a Boolean algebra in abstract terms. Resting as it does on the foundations laid in the first chapter, this development is natural and easy to follow, even for the beginner. The third chapter deals with the algebra of propositions, or symbolic logic, as a direct application of a Boolean algebra.

The next three chapters discuss the application of Boolean algebra to switching circuits, concluding with a brief mention of digital computer logic design. This is a most important application which the reviewer feels could have warranted more attention. The enormous complexity of present day digital systems has led to the development of quite sophisticated techniques for design and analysis. In particular there exist powerful techniques for handling many variables, for simplifying functions and for designing systems subjected to constants. For a detailed treatment of these topics the reader is referred to more advanced works on the subject (say Phister or Ledley). This is a pity, since the general appreciation of these techniques would certainly have benefited from Whitesitt's clarity of exposition.

The seventh and last chapter introduces probability theory as a further application of the algebra of sets. Although the treatment is brief (12 pages), many fundamental ideas are developed and the relationship of probability to Boolean algebra is clearly shown.

The book is based on a one semester (half year) course given by the author at Montana State College. It contains a large number of problems (some with solutions) designed to develop the manipulative skills of the student. Each chapter includes a short list of references and an adequate index is provided.

In summary the book, as a primer in Boolean algebra, succeeds in its aims and is to be strongly recommended.

N. E. WISEMAN

Texture—Boon or Bane?

Textures in Metal Sheets. By F. A. UNDERWOOD. *Macdonald.* (28*s*)

This book is the first, to the reviewer's knowledge, to be devoted exclusively to the subject indicated by the title. The word " texture "—a term of many nuances—is here used to denote a statistical bias in the spatial orientation of the crystal axes of the many individual grains in a sheet of metal or alloy. A statistically truly random orientation distribution of the grains is a rarity; according to the mechanical and thermal pretreatment of the material, it may possess a very loosely defined preferential " texture," or at the other extreme it may have so sharp a texture that the crystal axes of all grains are parallel within a few degrees. The book under review is concerned with the methods of identifying the crystallographic nature and sharpness of textures, the methods of denoting these graphically, the mechanisms by which textures come about, and their influence on mechanical and magnetic properties of sheets.

The author has addressed himself to people who already possess an elementary knowledge of crystallographic concepts, including the elements of X-ray diffraction; to understand the more theoretical parts of the book in which the physical origin of textures is discussed, some familiarity with the crystalline mechanisms of plastic deformation and of recrystallization is also called for. A reader possessing this background should have little difficulty in following the text and will acquire from it an adequate grasp of the principal facts, their practical implications for the engineer and the theoretical puzzles they provide for the metallurgist. He will also acquire a cursory acquaintance with the relevant experimental methods, but he should not regard the text as a sufficient handbook if he wishes to try his hand at determining textures for himself. For this purpose (especially for Geiger counter methods), he will still have to go to the original literature. The criticism needs to be made that the author is rather unsystematic in defining his terms, and sometimes does not do so until a term has already repeatedly been been used. The term " reflexion circle " is a case in point.

If the reader belongs to the minority of people whose gift for visualizing spatial relationship is inadequate, he will need more help than this book alone can give him if he is to understand clearly the basic principles of textures; for such people, the appropriate chapters in older books, for instance in Henry, Lipson and Wooster's book *Interpretation of X-ray Diffraction Photographs*, will still be helpful. In this connection, the generally poor quality of the illustrations in the book under review does not help; the publishers would have been well advised to have them redrawn to a standard style.

It is unfortunately true of this as of so many other fields of physical metallurgy that a gulf is fixed between the matters that are of direct practical interest and those that excite the curiosity of the scientist. Briefly, for most purposes it is a disadvantage to have a pronounced texture in a metal sheet, since this leads to anisotropy in the elastic and plastic properties, making the material less suitable for such uses as deep drawing. The X-ray methods described by Dr. Underwood serve as a means of finding out whether texture is present (with a view to finding ways of removing it). However, a simple cupping test, requiring a few seconds, will also serve the practical man, who is anyway totally uninterested in the crystallographic minutiae of textures in the classical materials such as copper and brass. These minutiae are of interest mainly to the cloistered scientist.

For this reason, it is a pity that Dr. Underwood has not devoted more space to the instances where textures are a boon, and where correspondingly the crystallographic details become of pressing practical interest. Specifically, this includes the textures sought in transformer steel to improve the permeability for fields in certain directions parallel to the plane of the sheet (which in turn permits, in the annual aggregate, savings of millions of pounds' worth of weight in transformer cores). It is indeed true, as Dr. Underwood says, that much commercial secrecy remains in this field, and this is especially true with respect to the recently developed " cube texture " in transformer steel, which allows further economies in comparison with the texture normally employed. Recent papers have, however, given a good deal of background information on this topic, and especially on the crucial importance of surface energy in determining the final

orientation of the surviving crystal grains. These matters might well have been discussed at some length, for they offer a field of common interest to the engineering user and to the physical metallurgist who examines the textures. However, much of this material is recent and may have appeared too late for inclusion by the author. A paper by Detert, in *Acta Metallurgica* for 1959, is particularly illuminating on this subject.

Texture is also of central importance in determining whether beryllium sheet can be usefully shaped for making nuclear components or aeroplane parts. (To a lesser extent, the same thing is true of magnesium alloy sheet.) A whole technology has grown up in the last four or five years, concerned with controlling the fine crystallographic details of the texture of beryllium sheet, and here the relevant X-ray diffraction methods really come into their own. The whole practical future of this metal will largely depend on the outcome of attempts to improve the texture.

The author is in no way to blame, of course, for the polarization of his subject between practical and fundamental interests and, given this intrinsic difficulty, he succeeds in giving good value to both groups. The index is good, and in particular the bibliography is extensive and a most useful feature of the book. It does not take long to read and is not expensive, and all in all it can be recommended as a good introductory text on its subject.

R. W. CAHN

Electrical Networks

Linear Graphs and Electrical Networks. By SUNDARAM SESHU and MYRIL B. REED. *Addison-Wesley Publishing Company, Reading, Massachusetts and London.* (74*s*)

Electrical network theory is one of the most highly developed branches of applied mathematics. Its familiarity tends to obscure two facts which are obvious on reflection: that with its aid very ordinary engineers can solve, to an adequate degree of approximation, problems which may be of daunting complexity if tackled from first principles; and that this success depends upon a two-fold abstraction which enables an elaborate physical structure to be represented by a few essential properties.

The first stage of abstraction is to represent practical conductors and components by idealized lumped elements: resistance, inductance, and capacitance. The second stage is to represent their couplings and interconnections in an equally abstract way, ignoring physical size or location (which may, however, affect the number, type and magnitude of the lumped elements themselves). In this step geometry is replaced by topology.

Now in conventional network analysis we use all the information specified on the circuit diagram to compute, in detail, the behaviour of the network. Conversely, in synthesis, we use the specified behaviour to compute, in detail, the elements of the network. But again, real progress hangs on further simplification; so we seek to establish general properties of a class of networks, to reduce a still complex specification to one or two parameters. One approach is to tabulate, once for all, the properties of a useful class of network such as derived filter sections, which can thereafter be applied in a variety of situations. Again, one may use the methods of function theory to derive such general principles as conservation of gain-bandwidth, or bounds on transient response of realizable networks. Yet another approach, less known than the first two, is to ask: what does the network topology tell us? Ignoring the elements, can we deduce anything from the pattern of their interconnections?

The fundamentals of network topology were discovered by Kirchhoff and Maxwell in the very infancy of network theory. Coming to the present day, most engineers are acquainted with some topological properties: for example, the relation between the numbers of loops, nodes and branches; or the fact that a ladder network is always minimum phase. But it is only within the last decade or so that the subject has really proliferated, and only now that a text-book entirely devoted to it has appeared.

It should be said at once that this is a very good book. The authors are both major contributors to the subject and (with one exception, noted below) they have properly assimilated the work of others, whether pioneers, contemporary engineers or pure mathematicians. The outline which follows does scant justice to the wealth of information and insights which they present.

Topological properties can be specified in two ways. We may draw a diagram of interconnections, looking like a circuit diagram with each branch reduced to a simple line; this is the linear graph. Or we may make a list of the branches, nodes, loops or other entities, and enumerate systematically the relations between them. This leads to symbolic representation in the form of a matrix, for instance the incidence matrix with a row for each node, a column for each branch, and a unit element for each incidence of a branch at a node. The graph is intuitively valuable, the matrix more amendable to manipulation. The authors' approach to graph theory, making great use of matrices, takes up nearly half the book. The reader requires no prior knowledge of graphs, but he should be familiar with matrix algebra and willing to follow abstract mathematics in fair detail.

The remainder of the book gives applications to the analysis and synthesis of linear networks and to switching theory, too varied for concise summary, but of undoubted interest to practitioners in these fields. There is a good collection of problems, including a set of "research problems" whose solution would extend present knowledge, and a fairly complete bibliography.

There is one very puzzling omission. In the long gap separating the pioneers of network topology from its comparatively recent renaissance, one man was propounding the most general and abstract methods: Gabriel Kron, whose "transformation tensors" are closely related to the matrix of a graph. I have long hoped that someone would assimilate Kron's obscurely written, but powerful and original work into the main stream of network theory; which could well be done in something like the present context. Unfortunately his name occurs only once, even in the bibliography—in the title of a paper by another author. Let not this comment detract from a very fine work, which I recommend to any reader with the right prior knowledge and interest.

K. W. CATTERMOLE

Departures from Classical Elasticity

Sur les Distorsions des Corps Élastiques (Théorie et Applications). By VITO VOLTERRA and ENRICO VOLTERRA. *Gauthier-Villars, Quai des Grands-Augustins 55, Paris.* (24 *NFr*)

Large Elastic Deformations and Non-Linear Continuum Mechanics. By A. E. GREEN and J. E. ADKINS. *Oxford University Press.* (55*s*)

An Introduction to Applied Anisotropic Elasticity. By R. F. S. HEARMON. *Oxford University Press.* (35*s*)

Classical elasticity theory was developed on the assumptions of infinitesimal strains, isotropic materials, strict continuity of displacements and the absence of any permanent set. In many materials of engineering importance today, not all these assumptions are even approximately true. In rubber and rubber-like plastics, it is necessary to consider finite changes of shape, although for many purposes progress can be made by assuming isotropy and a purely elastic response to stress. In single crystals, wood, laminated materials and stiffened plates the complications of anisotropy cannot be ignored, but otherwise these materials can be considered classical in their elastic behaviour. On the other hand, the engineer is often required to consider the possibility of the yield point of a structural material being exceeded locally in service, even while the strains are small and while the material may be regarded as isotropic up to the beginning of plastic deformation; the beginning of plastic flow is intimately bound up with the occurrence of discontinuities in the displacement of the material, examined on a sufficiently small scale. The three books now under review treat, separately, some of the main possible modes of departure from the classical elastic response of solids to applied stresses.

The centenary of the birth of Vito Volterra (1860) has been marked by the publication in France of his work *Sur les distorsions des corps élastiques* (*Théorie et applications*), originally based on his lectures given at the Institut Henri Poincaré in Paris and now revised, extended and brought up to date by his son, Enrico Volterra. It must be remembered that the French word *distorsion* was introduced by Volterra to describe a discontinuity in displacement across a small surface inside an elastic body—a term now generally superseded by the English *dislocation*—and it is in this sense that *distorsion* is to be understood throughout the book. The work under review is of a special historical interest because it describes the original classification of Volterra dislocations and the fundamental elastic continuum theory connected with them, basic concepts that have made possible the development, rapid in recent years, of the dislocation theory of modern solid-state physics.

In the first two chapters, a series of formal proofs is presented of theorems in classical elasticity relating to a displacement discontinuity surrounded by a multiply-connected region of homogeneous, isotropic elastic solid. In a third chapter the effect of introducing, in turn, six different types of Volterra dislocation in a thick-walled hollow cylinder is considered in some detail. Excellent agreement is reported with experiments on sections of thick-walled rubber tube, used in preference to a harder Hookean material in order to have observable deformations present at small stresses. Further agreement of the theory with experimental observations on stresses, making use of photoelastic techniques, is also demonstrated.

The fourth and final chapter is devoted to some engineering applications, particularly to loaded structures in which stress concentrations are relieved because of local plastic deformation, and structures in which stress concentrations in service are reduced because of local plastic straining, i.e. in effect by dislocations on a macroscopic scale, deliberately induced as a final step in the construction programme. The ideas presented here have had important applications, notably to bridges with large spans in reinforced concrete, especially through the compensation techniques associated with the name of Freys-

sinet, which may have to be applied at intervals during the period of several months while the concrete in a new structure continues to contract after hardening.

In *Large Elastic Deformations and Non-Linear Continuum Mechanics* by A. E. Green and J. E. Adkins, a mathematical treatment is given of rubber-like elasticity without restriction to isotropic and incompressible materials. The book is a sequel to *Theoretical Elasticity* by A. E. Green and W. Zerna, in which anisotropy and compressibility were largely ignored. Except for some generalizations of the theory in a final chapter, the materials considered are ideally elastic, in that they always recover an initial unstressed configuration when applied stresses are removed. Finite extensions are considered without approximation, so that the theory includes within its scope all rubbers and rubber-like plastics (provided these are not stressed to the point of permanent deformation). A systematic tensor notation is used throughout.

The relationships between stresses and finite strains can always be expressed in terms of the elastic strain-energy function that is appropriate to a given highly elastic solid at a certain temperature. Strain-energy functions for all possible types of anisotropy, classified in terms of crystal symmetry classes, are fully discussed from a general theoretical point of view, and there follow applications to the deformation of cylinders, tubes, spherical shells and other simple shapes. Some of the complications arising from temperature changes, the stability of the deformed equilibrium state, and confirmation of the theory by experiments on vulcanized rubber are all treated in detail.

Many practical uses of rubber-like solids depend on reinforcement by means of strong cords (e.g. tyre cords) of a different material embedded in the body of the solid. These serve to restrict the types of deformation that are possible, as well as giving extra strength to the final product, and they introduce preferred directions (i.e. anisotropy) into an otherwise isotropic medium. Such special types of anisotropy, arising from reinforcements of different kinds, are included in the scope of the work and the effects of inextensible cords laid in certain directions on the properties of an otherwise rubber-like solid, receive particular consideration.

While this work sets out to treat the general theory of deformation in a comprehensive way, much attention is given to methods of solution of particular deformations problems, either by successive approximations or by simplification of the general equilibrium equations when certain symmetry or other special features in a particular problem are made use of. The approximate solution of two-dimensional problems, sometimes using complex-variable techniques, follows a general account of finite plane strain.

Here we have a well written treatise on the fundamental theory of anisotropic elastic behaviour with as few restrictions as possible. It should be studied by all those who seek a full understanding of finite elastic deformations.

A different aspect of anisotropic elasticity theory is treated by R. F. S. Hearmon in *An Introduction to Applied Anisotropic Elasticity*. In this book attention is confined to homogenous materials in which displacement gradients are infinitesimal, so that the equations of state are general linear relations between the components of stress and of infinitesimal strain, and in which any axis of crystal symmetry is in the same direction at all points. Such materials are completely characterized, so far as deformation is concerned, by at most twenty-one independent elastic constants, and the well-known relations between the elastic constants in each of the possible crystal classes are clearly set out. The early chapters contain an admirable summary of all the essential results in a form suitable for easy reference. The theoretical arguments on which they are based are given, though sometimes only in outline with full references to where the completely logical development may be found.

Subsequent chapters are devoted to methods of measurement of elastic constants of single crystals and of anisotropic sheets, with a useful selection of numerical values for many actual materials, and to the theory of equilibrium in some of the simpler types of deformation. There follows an account of the theory of elastic wave propagation, with somewhat more detailed accounts of waves in hexagonal and cubic crystals, including a brief treatment of surface waves. Nearly a third of the book is devoted to the theory of the equilibrium of anisotropic plates, bent by edge couples or by transverse loading, the theory of flexural and other vibrations of plates and their elastic stability. Throughout, there is a successful mixture of calculation and comparison with experimental results.

A useful bibliography completes what must be a very welcome easy reference book for anyone who has to deal with Hookean elastic solids in which privileged directions exist. It is intended as an introduction to the subject for physicists and engineers, and it seems to this reviewer to be entirely suitable for that purpose.

J. G. OLDROYD

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Electrical Equipment

Motors. CROMPTON PARKINSON LTD., Aldwych, London WC2. A brochure giving details of ac motors designed to meet difficult site conditions. Various types of enclosure are listed and their suitability for damp situations and the protection they give against contaminated atmospheres discussed in detail. 8 pp., illustrated.

Tape Recorder. EMI ELECTRONICS LTD., Recording and Relay Equipment Division, Hayes, Middlesex. A folder describing the RE321 portable tape recorder, which is claimed to be suited to the uses of broadcasting organizations and for recording data in industrial and scientific spheres. Illustrated.

Boiler Control System. JAMES GORDON AND CO. LTD., Dalston Gardens, Stanmore, Middlesex. Catalogue No. 120 relating to electrical automatic control equipment for small boilers. 8 pp., illustrated.

Electric Drives in the Paper Industry. ASSOCIATED ELECTRICAL INDUSTRIES LTD., Motor and Control Gear Division, Rugby, Warwickshire. Deals generally with paper manufacture and pulp preparation equipment and the variety of drives available for use therein. Recent developments and some new installations are included. 30 pp., illustrated.

Materials and Components

Bearings. POLLARD BEARINGS LTD., Ferrybridge, Knottingley, Yorks. A folder giving particulars of the bearing housings available, particulars of the bearings, and selected applications in various industries. Illustrated.

Silicones. MIDLAND SILICONES LTD., Lichfield House, Smallbrook, Ringway, Birmingham 5. A supplement, in the form of a folder, to the Midland Silicone News. Outlines the services offered, illustrates some of the uses to which the materials are put, and details the characteristics of these materials. Illustrated.

Petrol Hose, BS 33: 1961. BRITISH STANDARDS INSTITUTION, 2 Park Street, London W1. A new BS laying down requirements for electrically-bonded delivery hoses and hose assemblies primarily intended for roadside petrol pumps. Nominal hose bores are ¾ and 1 in. 16 pp, illustrated. 5*s* plus 6*d* postage.

New Books

Hawker Aircraft Since 1920. By FRANCIS K. MASON. *Putnam.* (63*s*)

Mr. Mason traces the history of the Hawker company's development, and examines each distinct type of Hawker aircraft, with the aid of three-view drawings and photographs. Production data and the service allocation of individual aircraft are fully recorded. Details of unfinished projects and notes on Hawker test pilots are appended.

Automatic and Remote Control: Proceedings of the 1st International Congress of the International Federation of Automatic Control, Moscow, 1960. Edited by J. F. COALES, J.R. RAGAZZINI and A. T. FULLER. 4 Volumes. *Butterworths.* (£45 the set)

The 350-odd contributions provide a very complete coverage of the present state of the science of automatic control. Volumes I and II are devoted almost exclusively to theoretical matters, covering such aspects as continuous non-linear systems, self-adjusting systems, statistical methods of investigation and signal composition. Components are the subject of Volume III—magnetic amplifiers, stepping motors, bridges and photocells; simulators and computers; pneumatic devices; control instruments. And Volume IV deals with applications, ranging from the process industries, through transport, to thermal and nuclear power.

Plasmas and Controlled Fusion. By DAVID J. ROSE and MELVILLE CLARK, JR. *Published jointly by Massachusetts Institute of Technology Press and Wiley, New York and London.* (86*s*)

Although written primarily as a graduate-level textbook, this should also be useful to established engineers and physicists who are about to enter upon the field of plasma physics. The first twelve chapters dwell on plasma physics, magnetohydrodynamics and gaseous electronics; the remaining four chapters are concerned more specifically with theoretical and experimental investigations of controlled fusion, including descriptions of mirror machines and the stellarator. There are plenty of chapter-end exercises.

An Introduction to Transportation Engineering. By WILLIAM W. HAY. *Wiley, New York and London.* (94*s*)

Professor Hay provides an exposition of that common core of principles and problems found in all modes of transportation—railroads, highways, airways, waterways and pipelines. Although not primarily intended to aid in the solution of practical field problems, it will enable the reader to evaluate the suitability of the various methods of transport for specific transportation problems.

Manufacturing Processes. By J. V. HARDING. *Chatto and Windus.* (25*s*)

Primarily intended for ONC students, this is an introduction to the workshop processes by which ferrous and non-ferrous metals and plastics are transformed from raw materials into finished products.

A History of Platinum. By DONALD MCDONALD. *Johnson Matthey and Company Limited, Hatton Garden, London EC1.* (35*s*)

The story is recounted from the point of view of the refiner and fabricator engaged in commerce and in the supplying of a market. Therefore, the emphasis is on the obtaining of supplies, the refining of the raw material, the fabricating of the product and the marketing of the results. Neither the recondite aspects of the geology of the deposits, nor the complex chemistry of Pt and its compounds are dealt with. The period covered is from the earliest times to the eighteen eighties.

The Reviewers

Mr. N. E. Wiseman holds an M.S. degree from the University of Illinois and a B.Sc. from the University of London. A member of the Institution of Electrical Engineers, he is chief engineer in the mathematical laboratory at Cambridge University.

Dr. R. W. Cahn, B.A., Ph.D., F.Inst.P., is Reader in physical metallurgy at the University of Birmingham. He is also a committee member of the X-ray analysis group of the Institute of Physics.

Mr. K. W. Cattermole, B.Sc., is laboratory head working on development of pulse communication equipment with Standard Telecommunication Laboratories Limited. He is also author of a book entitled *Transistor Circuits*.

Professor J. G. Oldroyd, M.A., Ph.D., Sc.D.(Cantab.), is head of the department of applied mathematics in the University College of Swansea. A former Fellow of Trinity College, Cambridge, he was earlier mathematical physicist in the fundamental research laboratory of Courtaulds.

Marketing

The Development of Power in India

A reference was made in these columns last week to the work undertaken by ASSOCIATED ELECTRICAL INDUSTRIES LIMITED in India together with details of their participation in the Indian Industries Fair. To coincide with the opening of the Fair, AEI gave a London preview on 9 November to a film which although highlighting their individual interests gave a most informative description of the vast strides India is taking in the development of electric power.

The new film, " The Peaceful Revolution," traces in an impressive way the manner in which India has grasped the vital need for her technical resources to be built up and for her natural reserves to be exploited for the welfare of the people and the greater industrial strength of the nation as a whole. In this enterprize, technical assistance and the supply of plant have been abundantly forthcoming from other countries with highly developed industry—notably Britain, the United States and the Soviet Union. The emphasis on the development of electricity is well justified as this represents the obvious means by which the centralized building up of power production can rapidly confer new possibilities throughout the country, not only for plant installations of all kinds, but for irrigation and the improvement of the people's living conditions. Many British firms have cooperated in this large-scale project—both to realize the power resources and to construct plant to increase the output of such basic raw materials as steel—the great plant at Durgapur, built by a consortium of thirteen British companies (the Indian Construction Company) being an outstanding example of the latter. In these and future undertakings in India, the commercial significance for Britain is very considerable.

In five years, India plans to double her supply of electric power, and in ten years to multiply it sixfold. At Bhakra, in the Punjab, the highest dam in Asia will incorporate ten giant hydro-electric generators, being in size the largest symbol of India's drive for economic independence. AEI are supplying five 90 MW generators for this scheme.

In addition to their work on the £85 million Bhopal project which will employ 30,000 workers, AEI have been concerned with half the electrical equipment at Durgapur, a £130,000 order for radio network equipment for a 720-mile pipeline in Northern India, equipment for Calcutta and Bombay Suburban Railways, motor and control gear for 54 wharf cranes for the Bombay Port Trust and with a 30 MW turbine generator for Ahmedabad Electricity Company Limited (Eastern Area).

The entire British contribution at the fair covers 66,000 sq. ft of which 40,000 will be occupied by the British Pavilion. This consists of two sections, the first, the official exhibit, " Britain: India's Industrial Partner," outlines the part played by Britain in the industrialization of India and includes sections on finance, transport, communications, power, industrial production, health and knowledge.

This is supported by the commercial display which accommodates 48 British firms whose displays have been designed as far as possible to provide practical examples of the general theme.

The Board of Trade has been instrumental in arranging the British exhibition.

Japan to Manufacturer Nuclear Reactors

THE WESTINGHOUSE ELECTRIC INTERNATIONAL COMPANY have signed a manufacturing and technical assistance licensing agreement with MITSUBISHI ATOMIC POWER INDUSTRIES, INC., of Tokyo, Japan.

Under the agreement, which has been approved by the Japanese ministries of trade, industry and finance, Mitsubishi will manufacture complete nuclear reactors and their associated auxiliary equipment. This includes closed-cycle water reactors and any future types developed by Westinghouse.

At the announcement, Mr. A. B. McClosky, vice-president, associated companies of Westinghouse International, said: " Japan is among the nations best situated to utilize atomic energy immediately to meet their growing power requirements and the agreement makes possible the cooperation of the best scientific and engineering talents of Japan and the United States."

One of the 26 companies in the Mitsubishi Group, Mitsubishi Atomic Power Industries was formed in 1958 and first established a link with Westinghouse earlier this year, when a contract was signed for a test programme on nuclear materials at the Westinghouse testing reactor at Waltz Hill, Pennsylvania.

New Lucas Company in India

Arrangements have been finalized between JOSEPH LUCAS LIMITED and T. V. SUNDARAM IYENGAR AND SONS (T.V.S.) of South India for the formation of a new company, to be known as LUCAS-T.V.S. (PRIVATE) LIMITED.

A new factory is being built in Madras and initial capital will amount to about £2 million of which £1 million worth will be plant and machinery provided by Lucas. Early production will, of necessity, include some imported components but a phased programme of changeover to indigenous production is planned.

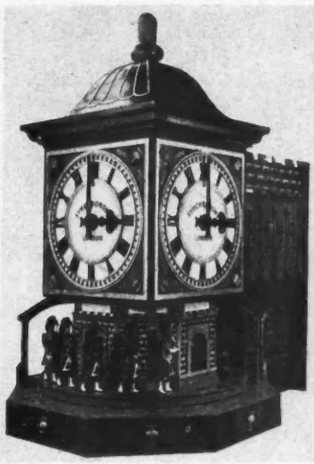
The new factory is expected to be operative by 1962 when 1,000 people will be employed, this figure being increased as development progresses. The Board will constitute three Lucas and three T.V.S. directors. Mr. T. S. Krishna of T.V.S. will be the chairman and Mr. J. W. Shield of Lucas is to be managing director.

The Indian motor vehicle industry is expanding rapidly and the electrical equipment produced by the new company will help to meet the ever-growing demand for components. By 1965, it is forecast that annual production will have risen to 100,000 units many of which will be produced by the Indian subsidiaries of British car manufacturers.

Automata Clock in Edinburgh

A new local landmark in the form of an automata clock now graces Princes Street, in Edinburgh. Designed and built by The SYNCHRONOME COMPANY LIMITED of Alperton, Middlesex, and erected on the corner of the House of Fraser, the design, most befittingly with its close proximity to Edinburgh Castle, depicts a portion of a castle surrounded by procession of pipers. These figures, four pipers and a pipe major, are mounted on a chain-driven track and circumnavigate the clock at each quarter chime. The detail of their uniforms, hand beaten out of copper, defies the most critical examination in its authenticity.

In addition to the Westminster quarter chimes and the hours, the tunes of " Scotland the Brave " and " Caller Herrin' " are automatically played at 7½ and 37½ minutes past the hour respectively. The notes are produced electronically, and the makers claim they provide the closest representation of bells ever achieved by artificial means. The 25 note compass, housed in a small cabinet remote from the clock, is equivalent to about 10 tons of bells.



The automata clock to be erected in Edinburgh by Synchronome is a beautifully detailed example of craftsmanship. Weighing one ton, it stands 11 ft 6 in high and projects 8 ft from a corner site.

The three clock faces are 3 ft in diameter and the hand actuating mechanism will be the same master unit that controls the rest of the clocks in the building.

The project represents six months of work for the craftsmen who built it and the estimated cost is in the region of £7,500.

Another Common Market Bridgehead

A new addition to the expanding ranks of companies who have established a link with countries within the common market is the LAMBRETTA/TROJAN GROUP of Croydon, Surrey. A new subsidiary company known as Trogian Italiana S.a.s. has been formed and will operate, under its commercial manager Sig. Italo Perottoni, from Via G. Fara 39, Milan. The group already have considerable interests in Italy as sole UK concessionaires for the Lambretta motor scooter, made by Innocenti of Milan.

The new company is expected to play a substantial role in the group's plans to increase exports of its marine and agricultural products and the Trojan car, for which the manufacturing and sales rights were recently obtained from Heinkel.

Railway Sidings at Steelworks

THOMAS SUMMERSON AND SONS LIMITED, of Mowden Hall, Darlington, have received a contract to provide railway sidings at the new Park Gate Iron and Steel Company plant at Rotherham.

Worth about £350,000, the contract is the largest single railway sidings order received since the company's inception. It includes almost 18,000 yards of flat bottom and bull-head rail and almost 100 turnouts.

Main contractors for the project are SIR ROBERT MCALPINE AND SONS LIMITED and the consulting engineers are BYLANDER, WADDELL AND PARTNERS of Sheffield.

BICC Cables for Malaya

The Central Electricity Board of the Federation of Malaya have placed a £330,000 contract with BRITISH INSULATED CALLENDERS CABLES LIMITED for the supply of some 60 miles of cable—power, control and telephone—for the Cameron Highlands hydro-electric scheme. The scheme is a far-sighted project involving 15 miles of tunnelling work and the construction of a dam, 120 ft high, three diversion weirs and two power stations. It will make a major contribution to the CEB's system, having a potential annual output of 320,000,000 kW hours and ultimately adding over 100 MW to the installed capacity.

The larger of the two power stations which will utilize the waters of the rivers Bertam and Telom will be located underground at Jor, 90 miles north of Kuala Lumpur. Eventually it will house four 25 MW generating sets operating under a gross head of 1,880 ft. Six miles to the north-east, the smaller station will accommodate two 2·75 MW sets.

Installation work will be carried out by British Insulated Callenders Construction Company Limited and the site work will occupy about 18 months. Completion of the contract is scheduled for August, 1963.

Nearer home BICC are to supply the cables for the new college building at Redditch College of Further Education in Worcestershire. Occupying nearly one acre the design of unusual interest affords 27,000 sq. ft of teaching and laboratory accommodation, 9,000 sq. ft of workshop and storage space and 5,000 sq. ft of communal space. BICC's contribution to the project includes various grades of mineral insulated copper covered cables, wiring cables and 660 volt pvc insulated plastic power cable.

The Glacier Reticular-Tin Aluminium Bearing

One of the Glacier Metal Company's best known thin-walled bearings, viewed against the background of their original concepts and methods of management.

PITY the poor engine bearing! It has to withstand heavy loading under not always perfect lubricational conditions until it either becomes worn out or breaks up. And if an engine fails with catastrophic results, it is often the bearing that gets the blame.

Ill-treatment of bearings is inevitable. For as long as an engine or machine comprises an assembly of fixed and moving parts, there are bound to be bearings—junctions between surfaces which are constantly moving in relation to one another.

Bearings not only act as media for supporting moving parts of an engine from static or other moving parts, but in reciprocating engines, for example, they have to carry high cyclic loads and load reversals. Sometimes journal bearings have additionally to take heavy thrust loads.

Since the bearings occupy critical positions in the engine, their size exerts considerable influence on overall engine dimensions. In consequence, there is a strong incentive, particularly in engines for the aircraft and the automotive industries, to keep the bearing size to the minimum. This search for reduced size gives the plain bearing an important advantage over the more complex and more space-consuming ball or roller variety. Thus, the plain bearing is still basic to engineering just as it has been for so many centuries.

The Glacier Metal Company is an organization 4,300 strong devoted almost entirely to the development, production and manufacture of plain bearings. But it is not only in the field of bearings that the company has achieved world-wide fame. The Glacier Research Project, a long-term investigation into organization, has created an enlightened and explicitly-defined system of management. The resulting clarity of perception has led the company into a continuous investment of a large part of its resources in the development of its products. The success of the company's reticular-tin aluminium bearing material which is the heart of the subject of this Product Profile must, therefore, be viewed in the context of good product development arising from a unique management philosophy.

In order to appreciate the achievement which the reticular-tin aluminium bearing represents, it is necessary to consider briefly the fundamentals of plain bearing design and glance at the preceding bearing materials. Normally, the design of a plain bearing is governed by two basic requirements:

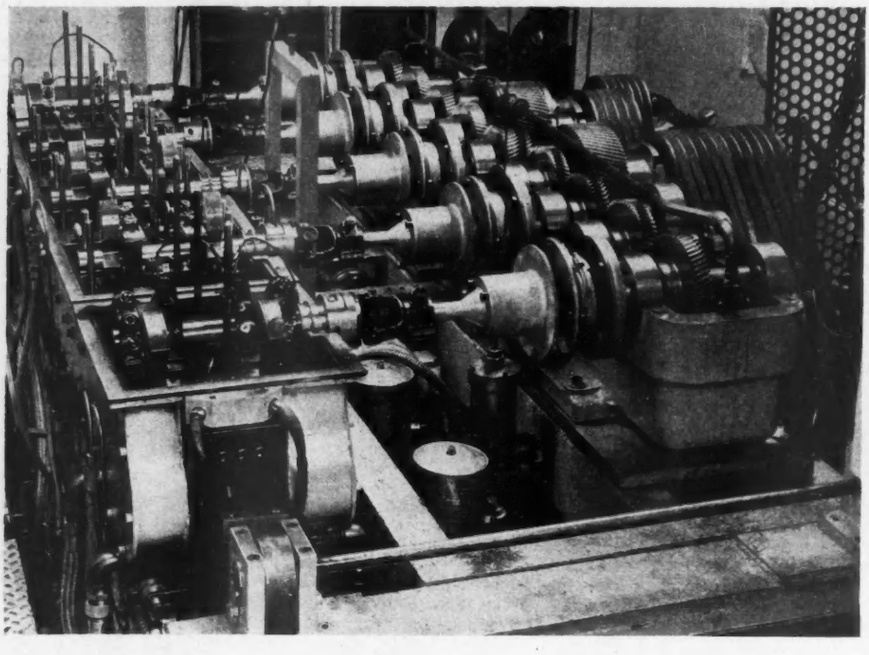
(1) lubrication in the form of a liquid film in order to maintain physical separation between the surfaces under normal running conditions, and

(2) some form of metallic lining to one of the surfaces in order to protect both surfaces from damage during momentary periods of loss of separation.

Taking the case of engine main bearings as a typical example, it is not sufficient for the metallic bearing lining, within which the crankshaft rotates, to remain immune from damage and wear at an extremely low rate; the crankshaft itself must remain in a relatively unworn condition, preferably without the expensive necessity of surface hardening.

The easy way to minimize wear on the crankshaft is to use a softer material for the bearing. Fortunately, too, a softer material itself wears away at a low rate, partly because it beds down to conform with the shaft during the running-in period. Unfortunately, if the material is too soft it loses mechanical strength and may start to disintegrate under load. So, as in many basic

Fig. 1 A glimpse at the research facilities, the engine simulator test machine.



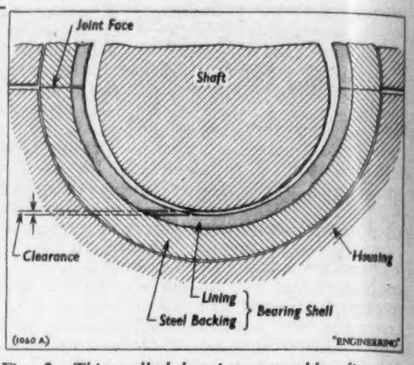


Fig. 2 Thin-walled bearing assembly diagram, with the surface irregularities exaggerated.

engineering features, the successful bearing material is the result of a compromise between the two conflicting requirements. And reticular-tin aluminium, which is exclusive to Glacier, is probably the best compromise yet. Increasingly onerous bearing space and loading requirements, associated with a growing desire to increase engine life between overhauls, have to be reconciled with a noise-conscious automotive market.

For many years, the principal bearing materials were lead-based or tin-based white-metal alloys. They are still used extensively in larger machinery, and in one bearing in four supplied to the automotive industry. The introduction of the thin-walled steel-backed bearing made possible production of white-metal lined bearings with much thinner linings. Today lining thicknesses of 0·005 in are commonplace.

An important increase in load carrying capacity arises from this thickness reduction. White metal linings have, since the war, been giving place rapidly to other lining materials but it is the steel-backed thin-walled bearing pressed from bi-metal strip into semicircular form that has become a Glacier speciality.

BREAKAWAY FROM WHITE-METAL

The first serious attempt to break away from white-metal lining took place during the early 1930's, when copper-lead mixtures were used. Later, the high wear characteristics of this lining were improved by electrodepositing a lead-tin overlay of a thickness between 0.0005 in and 0·002 in on the copper-lead surface, so creating the overlay or tri-metal bearing without increasing the overall thickness. But trials were soon made using aluminium as the basis of the bearing material plus about 5 per cent of tin, and this early form of aluminium-tin first came into use about 1936.

The new bearing material possessed adequate strength but there was room for improvement in its wear characteristics. So the tin content was gradually stepped up until it was found that after about 7½ per cent the strength of the bearing material began to suffer. However, aluminium-tin had come to stay.

During and after the War, the Tin Research Institute and the Glacier Metal Company carried out intensive research into the problem of increasing the tin content of aluminium-tin so as to improve the wear characteristics. The real breakthrough occurred in 1955 when it was discovered that by nodularizing the tin it was possible to increase its content up to 20 per cent. The resulting material is the one now known as reticular-tin aluminium.

The bi-metallic structure of reticular-tin aluminium is illustrated in Fig. 4. Its load-carrying capacity is two and a half times that of white-metal, and almost one and a half times that of overlay bearings. It does not require

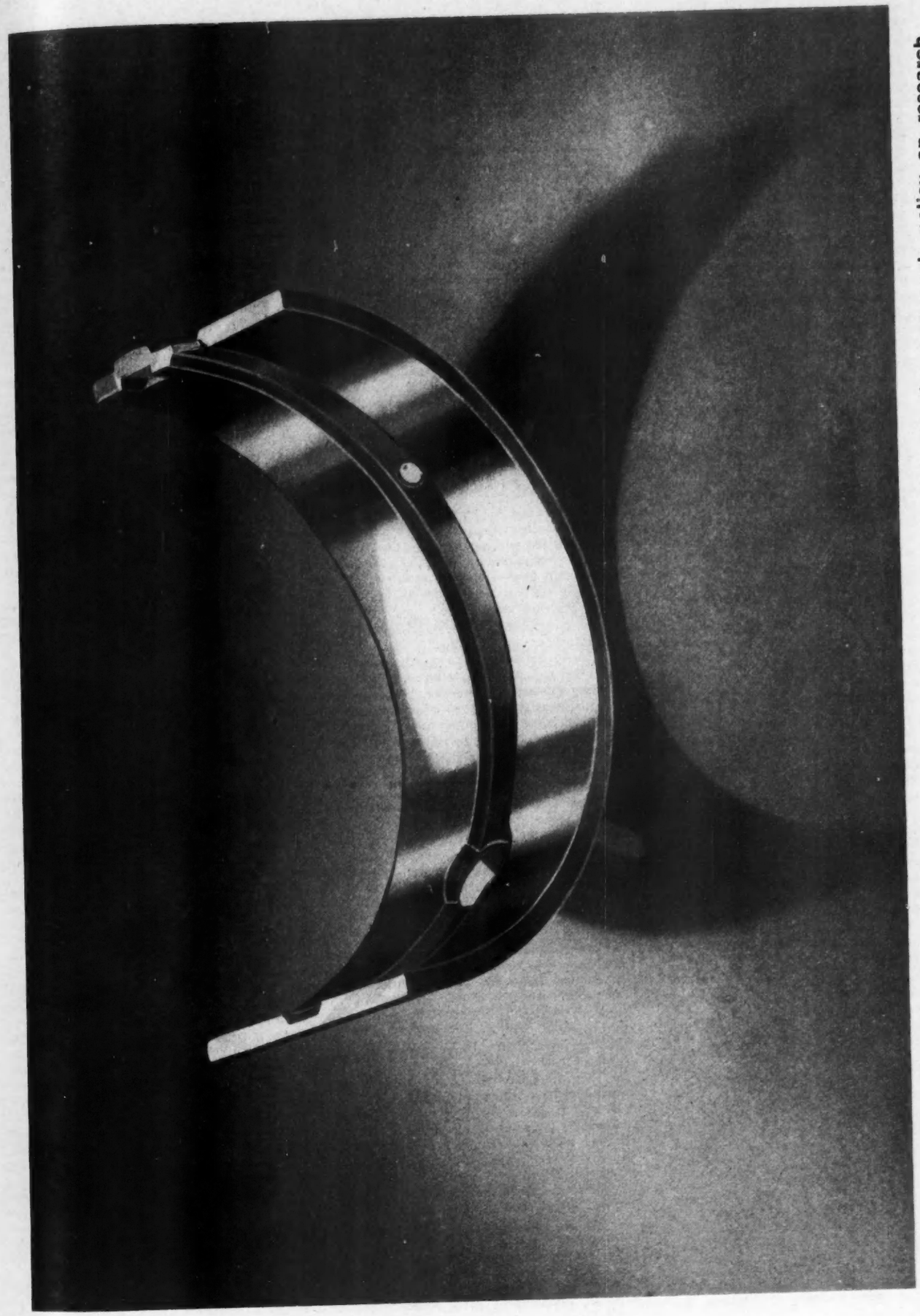


Fig. 3 Reticular-tin aluminium bearing: an exclusive product attributable to the company's policy on research.

a hardened steel shaft, and since the lining is homogeneous there is no overlay which, once removed in service, can give rise to an unacceptable increase in shaft wear. Another important point is its higher resistance to corrosion in internal combustion engines than other materials.

" Reticular " means net-like, and is used in this context to indicate the way in which the tin structure in the material is arranged. The aluminium grains make direct contact with one another, forming a continuous aluminium structure right through the alloy.

In conventional aluminium-tin, the tin takes the form of a coating around the grains of aluminium. So the strength of the alloy depends upon the strength of the tin which, in other words, solders together the minute particles of aluminium.

Because tin melts at a temperature which is not very much higher than normal engine bearing operating temperature, it is natural that such alloys should be weak. The difficulty is overcome by working and annealing the weak alloy so as to break up the offending film of tin. After this treatment, the tin is confined to the edges of the aluminium grains, leaving most of their surfaces in contact.

Glacier's thin-walled bearings are supplied in any size between $\frac{5}{8}$ in and 16 in shaft diameter. They may conveniently be classified under the three headings of white-metal, reticular-tin aluminium and copper-lead bearings, with or without an overlay. The type selected for any given customer requirement is based on the company's detailed application study and recommendation. The Glacier service includes recommending designs and lubricants, carrying out repairs, and investigating bearing failures.

The Glacier Metal Company were founded in London in 1899 by two Americans who were interested in the manufacture of anti-friction metals. One of the partners soon returned to America, leaving the other to build the company up and expand its products. Bearing manufacture was started during the First World War, and was the beginning of the present range of products; but it was the desire of industry rather than the particular wishes of the owner which determined the future course of the firm.

The company's unique concepts and methods of organization and management today have become the object of both curiosity and admiration by industrialists all over the world. This situation is due to the foresight of Mr. Wilfred Brown, who assumed control of the company as chairman and managing director on the eve of the Second World War. Mr. Brown has always maintained the faith that he would be a better manager of the affairs of his company if he became clearer about the bases of his own conduct as an executive. To this end, he enlisted the help of social scientists of the National Institute of Industrial Psychology and the Tavistock Institute of Human Relations. For the last fifteen years the Glacier Metal Company have been a centre of pioneer studies in the social sciences as applied to industry, and Dr. Elliott Jaques, formerly of the Tavistock Institute, is now the company's resident sociologist.

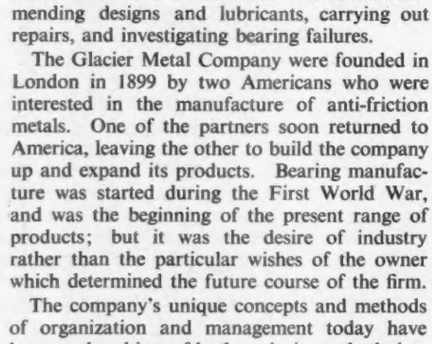


Fig. 4 Structure of reticular-tin aluminium alloy magnified 120 times.

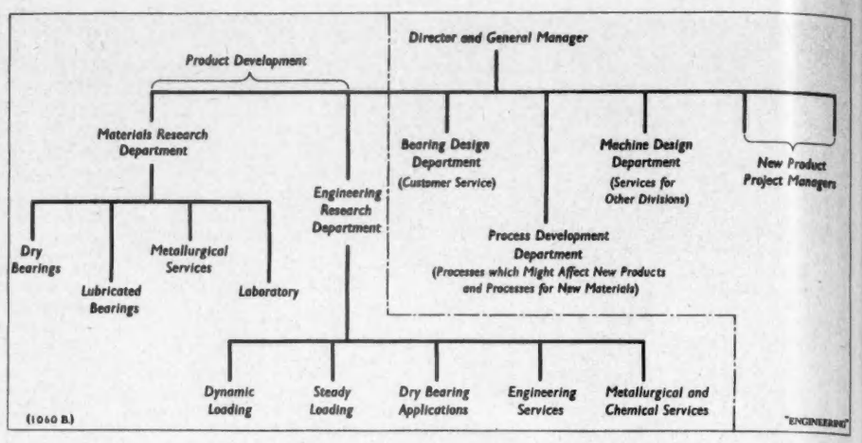


Fig. 5 Research and development organization.

ESSENTIAL INGREDIENT

One of the essential ingredients of the "Glacier system " is clear definition of all aspects of the work that forms the business of the company. It entails precise delineation of the " work role " into which each employee fits. In Glacier language, work is defined as comprising two major groups of components:

(1) the prescribed components, which are those things a person in a role must do, and

(2) the discretionary components, which are those decisions that the person must make.

Every manager, therefore, has clear-cut boundaries as to the extent of his authority but, within them, he has freedom to make decisions. The company's experience is that a manager is more likely to be reluctant to face up to making a decision expected of him than he is to complain of feeling restricted.

Broadly, the essential functions of a successful business—sound organization to develop good products, to manufacture and sell them—has been reinforced by a highly formulated knowledge of what makes up a good organization. The relation of organization to the work being performed is a necessary ingredient for success. Glacier can be said to get their work done by a process of setting policies and delegating work. To quote from Brown's recent book *Exploration in Management*: " It may be observed that the owners of every business carry out the following:

(*a*) They decide what goods or services they seek to provide. . . .

(*b*) They arrange for the provision of these goods or services. . . .

(*c*) They arrange for the sale of goods or services which they have brought into being."

It may be asked how does all this affect the company's success and, in particular, the new bearing material? The key lies, perhaps, in statement (*a*) which, if fully implemented, insists on a greater investment in resources in the development of the product than may be normal in British industry. Perhaps failure to pay sufficient attention to the product development responsibility is the Achilles heel of a very large number of British companies, and particularly of the smaller ones.

The Glacier Metal company carry out their product development in a research division employing 150 people. This function of product development is kept entirely separate from the important but different function of production engineering, i.e., improving the manufacturing techniques for existing products. Two senior men are separately responsible for these different functions, both answerable to the managing director. It is because of this ability to see two functions, which are often confused, as separate responsibilities that Glacier have a more than ordinarily successful record in the product development field. £1 million have been spent on product development in the last ten years, and the results include the introduction of the reticular-tin aluminium bearing material and the installation of plant to produce it; and also many other products.

Since reticular-tin aluminium is exclusive to Glacier, manufacturing licence agreements are eagerly sought and many have been concluded in different parts of the world. The money received in royalties is continuously ploughed back in the form of further product research and development, a policy which offers every prospect of putting the company in an impregnable position, technically and financially. The growing number of British firms taking up foreign designs under licence instead of developing equally good or better products of their own seems to point to a lack of proper understanding on the question of what percentage of the total turnover should be devoted to research.

Far from being confined to the company alone, their organizational concepts are shortly to be treated as a saleable service. The recently formed Glacier Institute of Management is a wholly-owned subsidiary which at present serves to acquaint new entrants to the company with the broad principles; but, in the near future, managers will be accepted from outside firms for a three week course.

An important aspect of thin-walled bearing production is the necessity for Glacier to manufacture much of their own tooling. A special department satisfies the requirements of their factories at Alperton near London and Kilmarnock in Scotland, and also of their manufacturing licensees. Such equipment is not normally offered for sale, but a recent exception was the acceptance of a large Russian order for a complete reticular-tin aluminium plant.

The story of reticular-tin aluminium bearings would not be complete without brief reference to its sales history up to date. Names like Ford, Vauxhall, Fiat, AEC, David Brown and F. Perkins are among the growing list of the important firms who use them.

The Glacier Metal Company Limited, Alperton, Wembley, Middlesex.

Automatic Data Recording

An automatic data recording system intended for use in laboratories carrying out research on semiconductors and electronic components, has been developed at the Battelle Memorial Institute, Columbus, Ohio, USA.

The device automatically measures the electrical properties of specimens and records data by typing them on paper and simultaneously coding them on paper tape. The coded data can be transferred directly to punched cards and fed into a digital computer to calculate the characteristics of the specimens.

Measurements can be made of current, resistivity, temperature, magnetic field strength, or any other property which can be translated into a dc voltage between 1 microvolt and 100 volts. Up to 17 different signals can be measured from a single specimen, or four different signals from each of four specimens, or any combination in between.

Properties such as resistivity, Hall coefficient, magnetoresistance, and thermomagnetic effect can be measured in any desired sequence and combination of sequences up to a total of 100 measurements. This set of 100 measurements can be repeated automatically at each of up to 100 variations in time or environmental conditions such as temperature, pressure or magnetic field. Thus, in a single programming, the machine can take and record up to 10,000 individual measurements.

By taking these measurements automatically and providing the data in a computer-ready form, the new device improves both the speed and efficiency of analytical investigations of materials and components.

New Family of Niobium Alloys

After six years of research, engineers of the Westinghouse Electric Corporation, USA, have now revealed the development of a new family of "space-age" alloys. The new materials are all alloys of niobium, which is noted for its strength and corrosion resistance at very high temperatures.

The family of niobium alloys is said to exhibit the best balanced combination of properties yet achieved with this important refractory metal. High strength at high temperatures is attained without drastic loss of the metal's inherent workability and low-temperature ductility.

"Both properties are crucial for space applications," said Dr. Herwald, Westinghouse Director of Research. "Without workability, the fabrication of spacecraft would be extremely difficult and costly; without low-temperature ductility, the intense cold of outer space would render the structure brittle and unsafe."

Compared with most refractory metals, the new alloys are light in weight, with a density about equal to stainless steel. Yet they can operate at temperatures in the range of 1,800° to 3,000° F. "These are basic requirements of structural space metal," Dr. Herwald emphasized. "For example, light weight simplifies the launching of the vehicle into space. High temperature operation makes possible smaller, more efficient engines to power it, and permits its safe return to earth in spite of the terrific heating by friction with the atmosphere."

The properties of the new family of niobium alloys are sufficiently promising for three of them to be put into pilot-scale production at the Westinghouse materials manufacturing plant at Blairsville, Pennsylvania. The first to be produced will be a niobium-vanadium alloy called B-33. This alloy has moderate strength and is easily fabricated and welded. It has unusually good resistance to corrosion by liquid metals.

"One application being considered for B-33 is in the heat exchangers, or radiators, of spacecraft," Dr. Herwald said. "The only means of getting rid of waste heat in space is by radiating it away at high temperatures. When unfolded in space, such a radiator might be as large as a football field. Only a strong, light, high-temperature and easily fabricated metal would be feasible."

From the metallurgist's point of view, the new family of niobium alloys are said to be remarkably easy to handle. They can be forged, rolled, sheared and handled directly, often at room temperature. Usually such processing must be carried out at high temperatures and in an inert atmosphere, or within the protective cladding of a less active metal. The new alloys require such protection only during melting and hot forming. Simple, inexpensive, well-known processing techniques are used thereafter.

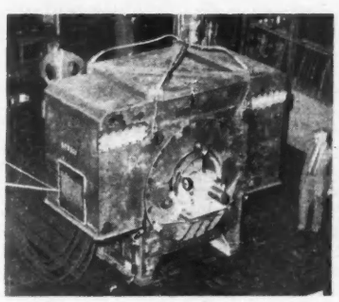
The two additional niobium alloys to be pilot-produced are B-66, a niobium-vanadium-molybdenum-zirconium alloy, and B-77, a niobium-tungsten-vanadium-zirconium alloy. Each of these alloys shows unusually high strength, while retaining ease of working and fabrication.

Two-Speed Induction Motors

The world's largest two-speed single winding squirrel-cage induction motors were recently demonstrated at the Trafford Park works of Lancashire Dynamo and Crypto, a company in the Metal Industries Group. They are not limited to 2:1 speed ratios.

Speed changing in the new motors is by pole-amplitude modulation, an invention of Professor G. H. Rawcliffe, Professor of Electrical Engineering at Bristol University, which has been developed in collaboration with the National Research Development Corporation and several manufacturers. Lancashire Dynamo and Crypto have produced the first commercial machines, which are intended for use in power stations in Europe.

Speaking at the demonstration at Trafford Park, Professor Rawcliffe said: "Tesla (Nikola Tesla, American electrical engineer and inventor, 1857 to 1943) gave the single-winding induction motor one speed; we have given it another. The induction motor is the world's most important power drive, and the flexibility obtained by this method of changing the speed will increase its potential value greatly."



The world's largest two-speed single winding squirrel-cage induction motor was recently demonstrated by Lancashire Dynamo and Crypto Limited.

Many ingenious methods for changing the number of poles of ac stator windings by reconnection have been devised over the last 65 years. In spite of this, most multi-speed motors have been built with at least two separate stator windings. The use of single-pole changing windings has been limited almost completely to the 2:1 speed ratio. Earlier schemes for other speed ratios required a large number of terminals and expensive control gear.

The invention of the pole-amplitude modulated winding has considerably extended the range of commercially attractive single winding two speed motors with only six terminals and a relatively simple controller.

Pole changing is accomplished, as in the case of the familiar 2:1 tapped winding, by the reversal of one portion of the two-layer lattice winding with respect to the other. On the 2:1 tapped winding, alternate pole groups are reversed for pole changing. With pole-amplitude modulation, selected halves of the phase windings are reversed with special grouping of the coils and, in some cases, omission of certain coils to improve the magneto-motive pattern.

Measurement of Steel Grain Size

Various elements are used to control grain size, which is an important factor in determining the characteristics of finished steels. The most widely used is aluminium, which inhibits grain growth by raising the grain coarsening temperature of steels.

An investigation to determine the percentages of aluminium which will give effective grain control, and to find the optimum method of addition, has been carried out by the Steelmaking Division of the British Iron and Steel Research Association.

From this it has been established that the grain coarsening temperature rises as the aluminium content is increased, and reaches a maximum point when the content is 0·04 per cent. If consistent production of fine grain size is to be ensured, the aluminium content must not drop below 0·01 per cent. It was also established that the moulds and pouring trumpets are the most effective points at which to make aluminium additions to molten steel, the aluminium losses here being the smallest.

An interesting conclusion drawn from these tests is that the measurement of aluminium content of a steel provides a quick, reliable, and less expensive alternative to the McQuaid-Ehn Test for evaluating grain size.

Electroslag Welding for Class 1 Vessels

By using electroslag welding for the longitudinal seams of the Dungeness Nuclear Power Station's heat exchangers, Head Wrightson and Company Limited are pioneering the application of the electroslag technique in the field of class 1 pressure vessels.

This achievement has been made possible by cooperation between the company's manufacturing and research and development divisions, which has enabled many technical problems to be overcome successfully.

The electroslag welding machine being used is one of Russian manufacture and is said to be the only one of its type in the United Kingdom.

The steel shell plates of the heat exchangers are between $2\frac{15}{16}$ in and $3\frac{7}{8}$ in thick, conforming to BS 1501-161, Grade C. Each tier consists of four plates, requiring four electroslag welds per tier, and is furnace normalized after the completion of the welding. There are six tiers to a heat exchanger and the circumferential welds joining the electroslag welded tiers together will be made by submerged-arc welding. All the welds are subjected to 100 per cent radiography test and, in addition, ultrasonic inspection will be carried out on all welds in plate thicknesses greater than $3\frac{1}{2}$ in. The completed heat exchangers will be 75 ft long with $23\frac{1}{2}$ ft internal diameter.

The working pressure is to be 295 lb per sq. in; the temperature being 420° C at the gas inlet end (shell thickness $3\frac{7}{8}$ in) falling to 342° C at the gas outlet end (shell thickness $2\frac{15}{16}$ in).

It is now more than twelve years since the electroslag welding technique was developed in the USSR. However, despite a number of apparent advantages in welding thick plate, it has only been over the past three years that British firms have shown an active (and increasing) interest in the electroslag process.

New Regenerative Heat Exchanger Concept

By D. G. Wilson, B.Sc., Ph.D.

A new concept in regenerative heat exchangers, which promises to overcome the disadvantages of leakage, carry-over losses and fouling in existing types, has been developed. Design summaries of units giving a "one-degree approach" in two typical applications are presented.

THE many advantages of regenerative heat exchangers in several applications are well recognized. The rotating matrix type has found almost universal acceptance as an air pre-heater for steam generators, where it recovers waste heat from flue gases. The stationary matrix periodic-flow type has long been used for blast furnace air heaters, and is finding increasing applications in the cryogenics field; for instance, the main nitrogen:oxygen:air heat exchangers in the low-pressure cycle oxygen process.

The advantages of regenerators stem mainly from the large heat transfer surface areas per unit volume that result from the use of small passages. The passages can be small because, firstly, the surfaces are not exposed to a pressure difference, nor do they separate the two fluids, so that a "matrix" of pebbles or scrap iron can in certain cases give a closer temperature of approach than would be obtained with a larger and much more expensive tubular exchanger. Furthermore the cyclic reversals of flow direction greatly reduce fouling. In any case, deposits are not so much a drawback because of their thermal resistance as is the case in tubular heat exchangers, but rather because of their low heat capacity and area-constriction.

When more sophisticated fillings than pebbles are used, another advantage accrues in that there can be a marked reduction in entry and exit losses. The contractions and expansions undergone by the entering and leaving fluids typically amount to 15 per cent in area ratio, as against 125 per cent for tubular and plate-fin heat exchanger headers.

When the qualities of resistance to corrosion and the comparative cheapness of the regenerative heat exchanger are added to this list of advantages, it is evident that they must suffer from several drawbacks which have prevented their wider use. The principal fault is the leakage of one fluid into the other occurring when gas is trapped in the matrix during the changeover between streams; this is often called the "carry-over loss."

When the two streams must not contaminate each other even minutely, any type of regenerator is obviously ruled out; but even in high-purity oxygen production this mixing by itself is not an overriding disadvantage. However it causes two additional penalties: firstly, if the two streams are at widely differing pressures, a considerable power loss results. Secondly, the thermal effectiveness, and therefore the temperature of approach, increases with more rapid reversals of flow—in fact the equivalent of true counter-flow conditions is only attained with an infinite frequency of flow reversal[1]—so that a compromise has to be reached between thermodynamic performance and power and mixing losses.

The periodic flow regenerator has an additional drawback in that abrupt fluctuations in flow are caused during the changeover, and consequently the outlet temperatures vary more or less sharply during the cycle. The rotating matrix type eliminates these variations at the expense of using a rubbing seal between the duct and the matrix (or housing) which leads to great difficulties in preventing leakage when the pressure differences are more than a few pounds per square inch.

While the passages of both types are fairly small, any significant further reduction in size is limited by the increased possibility of fouling when dirty fluids are used.

The present scheme aims at overcoming all these disadvantages, while providing some additional attractive features.

Continuous Strip Regenerator

The original impetus to produce a better heat exchanger was the promise of higher efficiencies for gas turbines if compact units having a close temperature of approach without high pressure losses and without rapid fouling could be designed. When the schemes given here were first discussed by the author (in 1957) it became evident that there was a wider and more fruitful field open.

The essential principle used is to transform the previous rigid matrix of conventional regenerative heat exchangers into one which could be compacted together without spaces where fluid could be trapped during the changeovers, but which could be rearranged when in contact with the fluid stream so that small flow paths existed. In this way carry-over loss would be eliminated, and fouling could not occur since deposits would be dislodged during the periodic compaction of the surfaces.

This principle was realized in two forms. The continuous strip type is illustrated in Fig. 1. A number of broad, thin, endless bands of a flexible material (e.g., steel, nylon) are moved round by means of rollers which are driven at a predetermined speed. The strips here are packed parallel to one another, with edges in line, in which form sealing is comparatively easily effected across the edges of the strip bundle and across the roller surfaces which squeeze the strips. After passing between the sealing rollers into the heat transfer ducts, the strips are spaced apart by separators, so that the fluids giving or taking up heat may have intimate contact with the strip surfaces.

This contact can be by the flow of the fluid in cross flow; that is, the flow direction is normal to the strip movement. A regenerator of this form was patented by Holmquist of Gothenburg, Sweden in about 1956. However, a cross-flow arrangement still demands an infinite strip speed for maximum thermal effectiveness, and a high strip speed has obvious mechanical limitations. The patent granted to the present author (working independently) in 1957 was for a true counter-flow arrangement, whereby the fluids are led into the strip gaps and then flow along against the strip motion. This typically gives maximum thermal effectiveness with strip speeds of the order of an inch per second.

A development of this arrangement promising greater simplicity at the cost of some design freedom is shown in Fig. 2. Here the role of the strips is taken by rotating flexible discs, squeezed together by conical rollers for sealing when the discs pass from one duct into the other, and spread apart by separators to give small flow passages within the heat transfer ducts. Again, true counter-flow conditions are attained with low rotational speed.

Applications and Advantages

The discussion so far has had in mind applications involving heat transfer between two fluid streams, probably gaseous. However, there is no obvious reason why the strips (or the discs) should not pick up or give up heat to liquids by conduction from flames by radiation or from vapours by condensation and boiling. Their use to remove heat from a slurry-fuelled atomic reactor can be envisaged, though sealing requirements would obviously be severe.

An application exploiting the non-fouling properties of this concept is concerned with the removal of CO_2 from air. In normal cryogenic work all CO_2 must be removed before the main heat exchangers lower the temperature to the point where the solid CO_2, if it were still present, would be deposited on the tubes and cause blockage and loss of performance. In the present devices no difficulty would occur as the deposits would be concentrated on the moving strips where they could easily be removed; in fact, in certain circumstances the exchanger could be used primarily for CO_2 removal.

By dividing the strips (or discs) and leading them to different heat transfer ducts, exchange of heat between several fluids can be carried out; Fig. 3 shows diagrammatically some possible arrangements. Fig. 5 shows a multipass cross-counter-flow arrangement of a heat transfer duct which may be employed without a large thermodynamic loss when true counter-flow operation would require excessively wide and numerous strips. Finally, Fig. 4 depicts a

Research Report

from the

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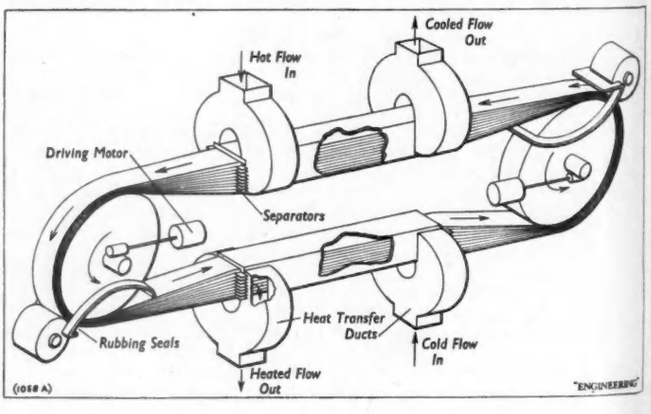

Fig. 1 Diagrammatic sketch of continuous strip regenerative heat exchanger.

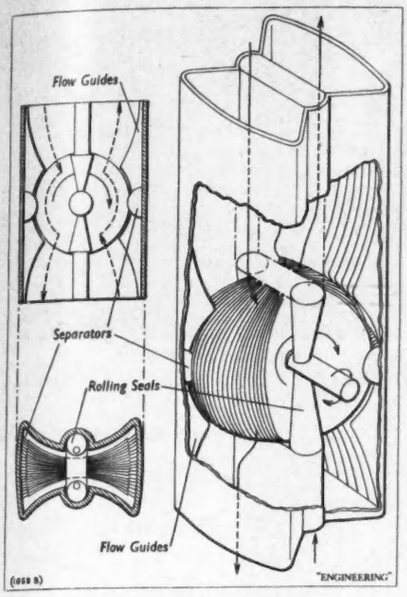

Fig. 2 Flexible disc type generator.

step-by-step arrangement which would be necessary when a very wide temperature range is to be covered down to cryogenic temperatures with close approaches, and is due to the rapidly changing specific heat of all metals and most solids at low temperatures.

Further design freedom is endowed by the ability to specify optimum spacings and flow lengths in each duct, an advantage possessed by no other type of heat exchanger.

Compared with existing regenerators, already good from their ability to resist fouling, these schemes with flexible surfaces, periodically scraped by separators and squeezed together between sealing rollers, can obviously withstand much worse conditions. Only very rapidly forming, sticky deposits should be difficult to deal with. Accordingly, present design studies are specifying far smaller passages than are used in matrix types, giving great advantages in thermal performance.

Carry-over losses are of course almost eliminated by the techniques of squeezing the surfaces together between rollers. In this form pressure sealing is carried out much more easily than in the rotating matrix regenerator, as the principal sealing surfaces are those of slow-moving rollers.

Thermodynamic Performance

Closeness of approach temperature, size, and pressure drops are interdependent. In a previous study on heat exchanger optimization[2], it is shown how the size of a heat exchanger of given performance and pressure drop goes down proportionately to the square of the passage (hydraulic) diameter. The very small passages permissible in the present device, coupled with the absence of internal separation losses, small entry and exit losses and absence of secondary surfaces gives a bonus that can be used to give it advantages over competing heat exchangers in any of these three vital attributes.

To illustrate the potential of the concept, two design studies are given below for conditions where a closer approach temperature than is economically realizable at present would yield considerable savings. They both concern low-temperature processes, since the loss of a given temperature difference causes a far greater loss of availability, by a Second Law analysis (and therefore a higher power loss) at low temperatures than at normal temperatures. Approach temperatures of five degrees (F) are often as close as is realizable without the increasing cost of the heat exchanger outweighing the savings in increased efficiency, though in certain applications three degrees can be realized. Here the results are given of design studies for a one-degree approach temperature in an air-nitrogen exchanger for a low-pressure oxygen plant, and the same temperature of approach in a typical de-methanizer feed cooler. A two-degree approach should be realizable in practice, if unaccountable losses are allowed for. The small "core" sizes and pressure drops obtained with the strip regenerator show the advantages which can be reaped.

1—Air Cooler

Design Input Data

Air inlet temperature	500 R
Air outlet temperature	130 R
Nitrogen inlet temperature	129 R
Nitrogen exit temperature	499 R
Air inlet pressure	10 atm
Nitrogen inlet pressure	1 atm
Mass flows of air and nitrogen	1 lb m per sec

The values used are chosen largely because of availability of data, and may not be truly typical of an actual design. A conservative strip spacing of 0·025 in was chosen, with a strip thickness of 0·015 in, a nickel alloy being envisaged (for these low temperatures other materials such as PTFE might be more suitable).

Overall Results

Heat transfer duct volume—30 cu. ft each for nitrogen and air sides.

Pressure drops—4·5 lb per sq. in, air side; 2·0 lb per sq. in nitrogen side.

Velocity of strips—0·2 in per sec.

To the duct volume, that due to the sealing rollers and headers must be added. The proportion of these to the total reduces as the mass flow increases. The low strip speed shows that the drive power required should be negligible.

2—De-Methanizer Feed Cooler

The feed composition is principally of H_2, CH_4, and C_2H_4, and the overhead of H_2 and CH_4. Equal heat capacity rates are assumed here, a conservative assumption.

Design Input Data

Overhead inlet temperature	316 R
Overhead inlet pressure	450 lb per sq. in (A)
Overhead outlet temperature	419 R
Feed inlet temperature	420 R
Feed inlet pressure	460 lb. per sq. in (A)
Feed Outlet temperature	317 R

The same strip thickness and spacing were assumed as for the previous case.

Overall Results

For 1 lb m per sec flow of each stream, Heat transfer duct volume	4·5 cu. ft
Pressure drop, each stream	1·0 lb per sq. in
Velocity of Strips	5·75 in per sec

Conclusions

Regenerative heat exchangers using continuous flexible elements should find wide applications when one or more of their different advantageous qualities are exploited. To date a small test model has been made to examine the mechanical features; the prime need is for a prototype to be put into service in an application where it has greatest advantage, and in which the inevitable teething troubles associated with a new concept can be overcome. It is hoped that this Research Report will stimulate interest in this direction.

Acknowledgements

Mr. D. N. Molesworth, of Ruston and Hornsby Limited, contributed valuable ideas during the initial working out of the scheme. Permission to present this paper was given by Northern Research and Engineering Corporation, where colleagues of the author were most helpful. A similar paper will be presented next month to the American Institute of Chemical Engineers.

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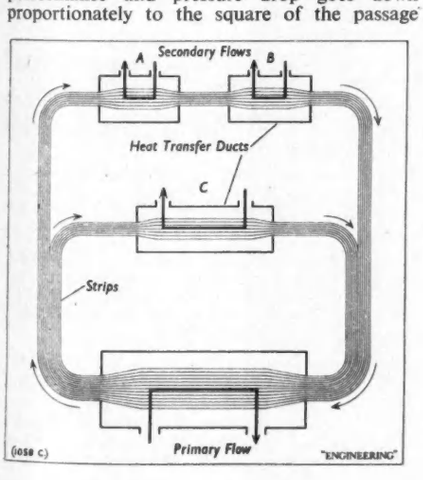
[1] Kays, W. M., and London, A. L., *Compact Heat Exchangers*, McGraw-Hill Book Company, Inc., New York, N.Y., 1958.

[2] Wilson, D. G., "Convective Heat Transfer and and Its Role in Gas Turbines", *Proc. Inst. Mech. Engrs.*, vol. 170, 1956.



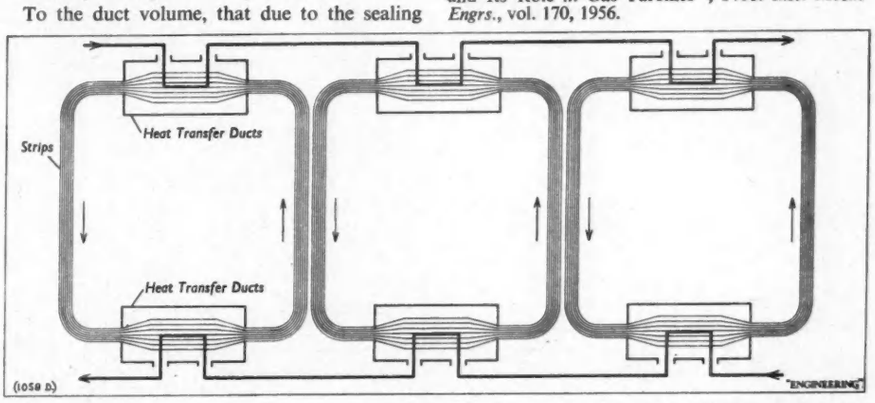


Fig.3 (left) Series-parallel multi-flow arrangement.

Fig. 4 (above) Step-by-step flow arrangement.

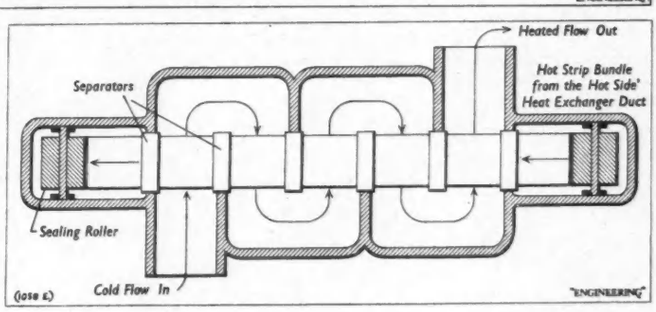


Fig. 5 (right) Heat transfer duct arranged for multi-pass cross counter flow.

Curtains Under Power

THERE are many occasions when it is very pleasant to be able to draw the curtains without having to get up to do it. In halls where cinema shows are given or slides are displayed during lectures, the convenience of remote control of daylight is an obvious advantage; the curtains can be drawn for the showing of the slides and opened for the taking of notes as the lecturer pleases. In the home, the practical advantages may not be so great but it would surely be a luxury. One gain would be that the drag on the leading edge of the curtain material caused by a vigorous hand would be eliminated, and as a result the risk of a torn curtain reduced.

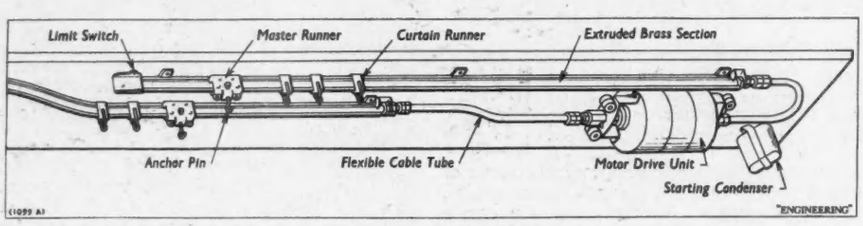
The scheme that has been developed by Thomas French and Sons Limited, Chester Road, Manchester 15, and known as the Rufflette brand, can be installed for use with most curtains. The curtain track and the electric motor that provides the power are mounted on a board which itself can form part of the pelmet or be mounted directly on the lintel or ceiling. Installations are made to measure using standard items and no limit is quoted for the length of travel of the curtains. Control can be by push buttons placed wherever convenient, and there are limit switches to prevent over-run.

The actual movement of the curtains is obtained on the track, support the weight of the curtain along its length.

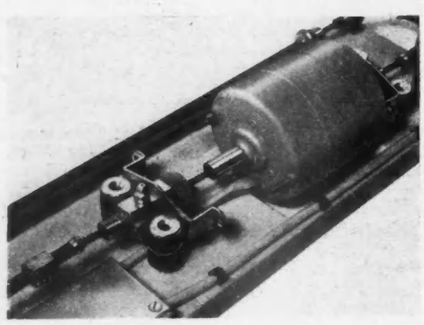
The limit switches are set at the inner end of one track and the outer end of the other. A length of cable is left projecting beyond the ends of the master runners and it is this cable end that actually operates the switches. Thus the curtains can be set very simply, and with considerable latitude, to give the required movement by adjusting merely the position of the master runners at the cable after the system has been installed.

The extreme flexibility of the cable allows a wide choice of layout and the system can be fitted to most requirements. Some idea of the curves that can be incorporated may be obtained from the fact that the headboard in the illustration is only 5¾ in wide yet accommodates the motor, track and starting condenser quite adequately. The limitation of the system is that the weight of the curtains should not exceed 66 lb for a single motor system. For heavier installations alternative arrangements are possible using two motors, so that the scope of the device can be extended to include curtains which exceed this limitation.

One of the special features claimed for the Rufflette system is that it is silent in operation and can therefore be used in many positions

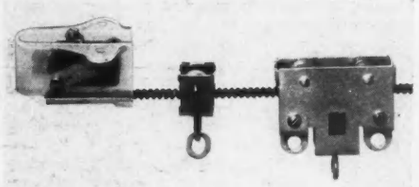


Part of an installation showing the drive motor and track mounted on a headboard 5¾in. wide. The flexibility of the cable can be seen from the loop at the right.



(*Left*) *The drive motor with the driving nut unit disconnected to show the flexible cable.*

(*Below*) *Limit switch (left), intermediate runner and master runner on a length of cable.*



by a long flexible cable which is anchored to two master runners at the leading edges of each half of the curtain. The cable, which is spirally formed so that in effect it is one long screw thread, runs in a channel in the lower portion of the track, there being a slot along the bottom to allow the connecting pin of the master runner to lock on to it. This locking pin can be withdrawn at any time so that the curtains can be operated by hand in the event of a power failure or other mechanical breakdown.

From the ends of the track the cable passes through tubing bent to shape and so through the hollow spindle of the electric motor, making a continuous length from one master runner to the other. The motor spindle drives a nut that screws the cable through, the direction depending on the direction of rotation of the motor. Since the motor is set between the inner end of one track and the outer end of the other, the movement of the cable either brings both master runners together at the centre of the curtain opening, or moves them to the outer edges, thereby of course closing or opening the curtains. Intermediate runners that move freely where noisy running would not be permissible. The track is an extrusion made normally in standard lengths which can be butt joined to make the run required for the set-up. The joining is carried out by the makers or by the authorized stockists and fitters. The motors are designed for operation on 220-240 volt ac supplies and the curtains can be fully controlled by the push buttons for movement in both directions, the limit switches only coming into play when full travel is desired. The controls can be single or grouped as desired so that several sets of curtains can be operated simultaneously. As mentioned earlier, by withdrawing the gripping pin, the curtains can be freed for hand operation and for this a cord can be permanently fitted to the master runners.

Although the Rufflette is designed for operating curtains there seems no valid objection why it should not also be used for other movements, providing the force required is not too great. Small valves, targets, and the remote control of optical instruments seem possibilities, and the flexibility of the cable would endear it to the designer.

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